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VARIATION IN THE NUMBER OF SEEDS OF THE LOTUS

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IN HIS *Mutationstheorie* (vol. 1, p. 112) de Vries puts at the head of a list of topics for further investigation by the student of variation the following sentence: "Das Quetelet'sche Gesetz bedarf immer weiterer Beispiele; die Zahl dieser kann nie gross genug werden." In view of this statement from so distinguished an investigator of the problems of evolution, I venture to publish some material on variation in Nelumbium which has been in my notes for some years and which has frequently been used as an illustration in classroom lectures in biometry. As will be seen in what follows, this material conforms very closely to the normal or Gaussian law in the distribution of its variates; much more closely in point of fact than do many cases which have commonly been cited as typical illustrations of that law.

In marshy situations at many points about the shores of the western part of Lake Erie the common lotus, *Nelumbium luteum* Willd., grows in great abundance.[1] Especially in a strip of water known locally as "Black Channel," which connects Sandusky Bay with the lake, does this plant flourish. Many acres of water are literally covered with its leaves. Pieters (*loc. cit.*, p. 66) says of the growth of Nelumbium in this region: "The immense yellow flowers rising just above the great dark-green standing leaves and the water covered with huge floating pads make this the most striking formation of the swamp. The Nelumbium grows in from

[1] *Cf.* Pieters, A. J. "The Plants of Western Lake Erie, with Observations on their Distribution." *Bull. U. S. Fish Comm. 1901*, pp. 57–79.

2 to 4 feet of water, or stray plants may be found in less than 2 feet. Many of the floating leaves were 20 to 24 inches across and the standing ones not much smaller. At Upper Sandusky Bay I found a floating leaf 26 inches in diameter and another with a petiole more than 5 feet in length. Both at Sandusky Bay and along the Portage River the acreage of Nelumbium was greater than at East Harbor, but nowhere did the plants present a more vigorous growth or so magnificent an appearance."

The large ovoid seeds of this plant are borne in pockets scattered

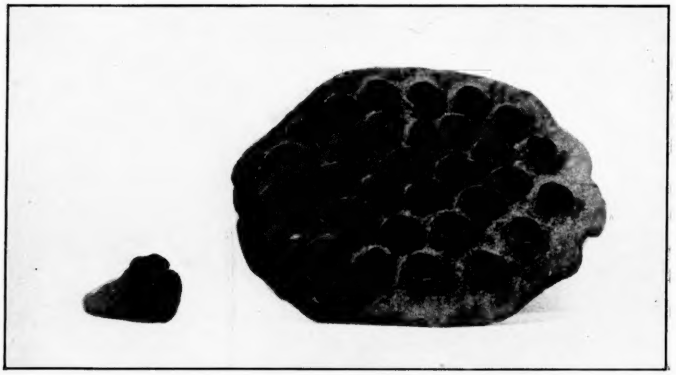

FIG. 1.— Showing the general form of the capsule and arrangement of the seeds in Nelumbium. The two capsules shown in this photograph represent the extremes of variation in the sample; the capsule on the left bore 9 seeds, and the one on the right 39. In the photograph both are reduced below actual size to the same degree.

over the flat, upper surface of the conical seed capsule. After the flower has been shed the ends of the seeds are seen projecting from these pockets. The form of the capsule and the arrangement of the seeds are shown in the accompanying photographs (Figs. 1, 2, and 3), for the preparation of which I am indebted to Miss Frances J. Dunbar.

It is the purpose of the present paper to set forth the results of a study of the variation in the number of seeds to the flower (or the capsule) in this plant. At the end of the flowering season in the summer of 1902 a series of 1410 seed capsules was collected at random from the Black Channel fields in Sandusky Bay. A

count was made of the number of seeds in each of these capsules and the records so obtained form the basis of this paper.

The raw data are exhibited in Table 1.

TABLE 1

Frequency Distribution of Number of Seeds in Nelumbium

Number of Seeds per Capsule	Frequency	Number of Seeds per Capsule	Frequency	Number of Seeds per Capsule	Frequency
9	1	20	60	31	45
10	0	21	101	32	34
11	0	22	111	33	21
12	2	23	113	34	13
13	2	24	114	35	11
14	1	25	107	36	7
15	13	26	137	37	2
16	11	27	120	38	1
17	30	28	101	39	1
18	41	29	90		
19	58	30	62	Total	1410

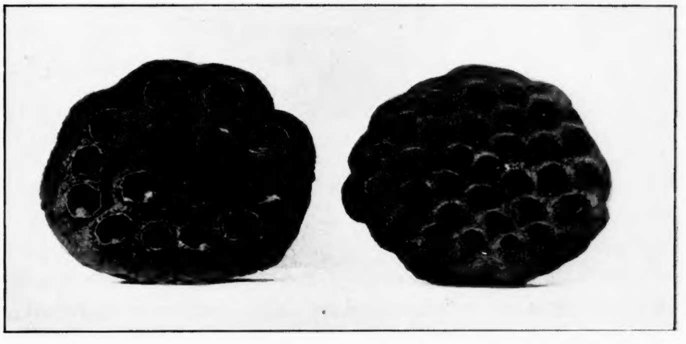

FIG. 2.— Showing two capsules of almost exactly the same size but bearing widely different numbers of seeds, the one on the left having 15 seeds while the other has 31. It should be noted that the openings of the seed pockets have been enlarged with a knife in the specimen on the left. The normal aspect of the capsule top is shown in the right-hand specimen.

The chief physical constants for this distribution are given in Table 2.

TABLE 2

Constants for Variation in Seed Number in Nelumbium

Mean	24.874 ± .078
Standard Deviation	4.339 ± .055
Coëfficient of Variation	17.445 ± .162

It will be noted that the distribution as a whole is quite symmetrical. The relative variability, as measured by the coëfficient of variation, is of the same general order of magnitude as has been found

FIG. 3.— A large, fully developed capsule seen from the side.

in plant characters by other workers. In order to determine whether or not the variation of the character under consideration follows the normal law within the limits of the errors of random sampling we must examine the values of the analytical constants, which define the character of a frequency distribution, in comparison with their probable errors. Using Sheppard's corrections for the moments I find the values given in Table 3. The unit for the moments is 1 seed.

TABLE 3

Analytical Constants for Variation in Nelumbium

Constant	Value
μ_2	18.8307
μ_3	2.4675
μ_4	1022.5949
β_1	0.0009
$\sqrt{\beta_1}$	0.0302
β_2	2.8838
β_2-3	—0.1162
κ_1	—0.2351
κ_2	—0.0029
Skewness	0.0164
Modal Divergence	0.0712
Standard Deviation	4.3394
Mean	24.8745
Mode	24.8033

Further, we have the following values for the probable errors of the chief constants concerned in testing whether the distribution sensibly deviates from the normal law. It will be understood that these are the values of the probable errors for the normal curve.

Probable error of skewness $= \pm\ 0.0220$
" " " $\sqrt{\beta_1} = \pm\ 0.0440$
" " " $\beta_2 = \pm\ 0.0880$
" " " modal divergence $= \pm\ 0.0955$

We see at once that neither the skewness, the difference between the mean and the mode, nor $\sqrt{\beta_1}$, are sensibly different from what they would be for an absolutely normal distribution. In the case of each of these constants the theoretical value for a normal curve is zero. The values found from the actual statistics in this reasonably large sample differ from zero by less than the probable errors. Hence we may conclude that in respect to number of seeds per capsule Nelumbium varies symmetrically about the mean (which of course coincides with the modal) condition. A half of the capsules bear less than the typical number of seeds, and a half more than the typical number. Turning to the quantity β_2-3, which measures the degree of flatness at the top of the curve, or, as it has been called

by Pearson,[1] the *kurtosis*, the case is somewhat different. Theoretically the normal curve is mesokurtic, or $\beta_2 - 3 = 0$. Now in the present case $\beta_2 - 3$ differs from zero by more than its probable error. The deviation is less than twice the probable error of β_2, so cannot be considered as significant on this basis. As we shall see, however, we get a somewhat better fit to the data given by the *actual sample* if we use a curve which takes into account this deviation from the mesokurtic condition of the normal curve. In so far, however, as we may infer from the sample regarding the conditions in the general population from which the sample is taken, we can conclude with a high degree of probability that *in the variation in number of seeds per capsule Nelumbium follows the normal law of errors.*

From the values of κ_1 and κ_2 given in Table 3 we see that whatever deviation from normality exists, is in the direction of a curve of Type 1. In order to compare the graduation given by a normal and a skew curve, I have fitted both types of curve to the data. The equation to the normal curve is

$$y = 129.6271 \ e^{-\frac{x^2}{37.6614}}$$

while the equation to the Type 1 curve is

$$y = 127.6421 \ (1 + \frac{x}{28.7285})^{21.7365} \ (1 - \frac{x}{32.1508})^{24.3259}.$$

Calculating out the ordinates of these two curves corresponding to the different numbers of seeds, we have the results shown in Table 4.

TABLE 4

Comparison of Observations and Fitted Curves

Number of Seeds per Capsule	Observed Frequency	Ordinates of Normal Curve	Ordinates of Type 1 Curve
9	1	.2	.06
10	0	.4	.2
11	0	.8	.5
12	2	1.6	1.2
13	2	3.1	2.6
14	1	5.6	5.2

[1] *Biometrika*, vol. 4, p. 173.

TABLE 4 (*continued*)

Number of Seeds per Capsule	Observed Frequency	Ordinates of Normal Curve	Ordinates of Type 1 Curve
15	13	9.7	9.5
16	11	16.0	16.2
17	30	25.0	25.7
18	41	37.0	38.3
19	58	51.8	53.6
20	60	69.0	70.8
21	101	87.0	88.4
22	111	104.1	104.7
23	113	118.1	117.7
24	114	127.0	125.6
25	107	129.6	127.4
26	137	125.3	123.3
27	120	115.0	113.3
28	101	100.0	99.0
29	90	82.5	82.3
30	62	64.5	65.0
31	45	47.9	48.7
32	34	33.7	34.6
33	21	22.5	23.2
34	13	14.2	14.7
35	11	8.5	8.8
36	7	4.9	4.9
37	2	2.6	2.6
38	1	1.3	1.2
39	1	.7	.6

Of course to get absolute accuracy, areas instead of ordinates should be compared with the observed frequencies, but inasmuch as the number of groups is here large, the error made by comparing ordinates will not be serious.

The frequency polygon and fitted curves are shown in Fig. 4.

The fit is seen to be excellent in the case of both the curves, but the slight superiority of the Type 1 curve is apparent. The difference, as has been pointed out above (p. 762), between this and the normal curve is not significant. The greatest discrepancy between the observations and the curves is in the region about the mode. I am unable to account for the curious irregularity in the

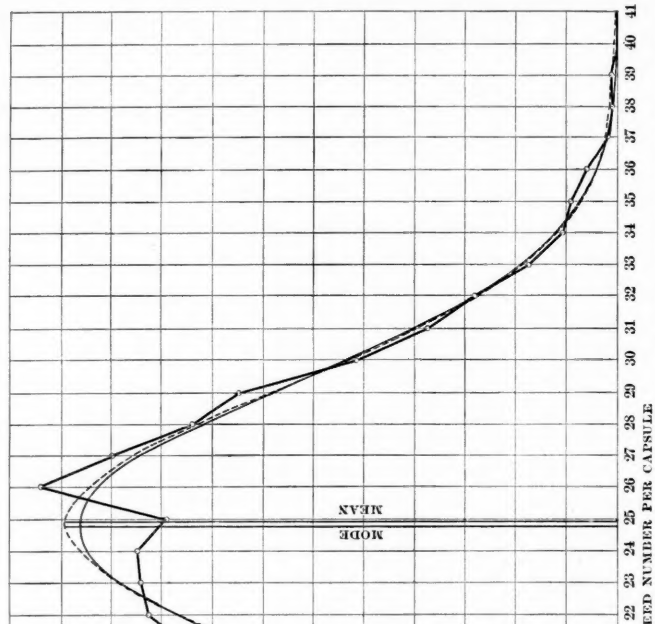

Fig. 4.— Diagram showing variation in the lotus. The abscissæ give seed number and the ordinates frequencies. o——o observations; ----, normal curve; ——, type I curve.

observation polygon in this region except as a result of random sampling.

The fact that this distribution approaches very closely to the normal type is indicated by the value obtained for the theoretical range of variation when a Type 1 curve is used. It will be recalled that this type of curve has the range limited in both directions, while the normal curve has an infinite range. Using the values of the moments given in Table 3, I find for the Type 1 curve:—

Total range	= 60.8794
Lower limit of range	= −3.9252
Upper " " "	= 56.9541

It is clear that the theoretical range greatly overestimates the observed. Of course the start at −4 seeds appears at first sight to be an absurdity, but it must be remembered that this value is subject to a considerable probable error, and that it is possible to get as great an extension as this of the range of the theoretical curve below zero as a result merely of random sampling. Furthermore it must be admitted that while the upper limit of the range at 57 seeds seems very improbable, yet, for anything we know to the contrary, it is not impossible.[1] In general it is clear from this case that as the Type 1 curve approaches the normal its range becomes greatly extended.

There is one further point regarding this material to which attention should be called, namely, the bearing of the results on the question of the distribution of fecundity. It is evident that the number of seeds borne by a plant is the measure of its fecundity. In considering data like those here presented the question at once arises as to whether each different class of capsules contributes its proportionate share in the total number of seeds available for the propagation of a succeeding generation. A moment's consideration shows that this cannot be the case in Nelumbium. The figures given in Table 5 demonstrate this. To avoid the possibility of misunderstanding, the manner in which this table is formed may

[1] Since writing the above I have seen some actual statistics of variation in seed number in the lotus in which the upper limit of the observed range is 42 seeds, showing a tendency in the direction predicted by the theoretical curve.

be stated briefly. The figures in the second column were obtained by multiplying the number of seeds in a given capsule by the frequency with which that class of capsule occurred in the sample. The third column gives the same data reduced to *per mille* proportions.

TABLE 5

Total Number of Seeds borne by Capsules of Different Sizes

Capsule Class (Seeds per Capsule)	Total Number of Seeds borne in all Capsules of Designated Class	Per Mille Number of Seeds borne in all Capsules of Designated Class
9	9	0.26
10	0	0
11	0	0
12	24	0.68
13	26	0.74
14	14	0.40
15	195	5.56
16	176	5.02
17	510	14.54
18	738	21.04
19	1102	31.42
20	1200	34.21
21	2121	60.47
22	2442	69.63
23	2599	74.10
24	2736	78.02
25	2675	76.27
26	3562	101.56
27	3240	92.38
28	2828	80.63
29	2610	74.42
30	1860	53.03
31	1395	39.77
32	1088	31.02
33	693	19.76
34	442	12.60
35	385	10.98
36	252	7.19
37	74	2.11
38	38	1.08
39	39	1.11
Total	35,073	1000.00

From this table we see that, in round numbers, 1400 capsules produce 35,000 seeds. Further, it is clear that the different classes of capsules do not contribute in proportion to their frequency of occurrence to the total seed number. Thus, for example, a reference to Table 1 shows that capsules with 21 seeds each and capsules with 28 seeds each occur with equal frequency in our sample. But obviously the latter will contribute more to the total number of seeds. As a matter of fact the 28-seed capsules contribute 81 per thousand of the total number of seeds, as against 60 per thousand of the 21-seed capsules. Taking the data as a whole I find by a very simple calculation that:

(*a*) Capsules with *fewer* than the median number of seeds bear altogether 15066.325 seeds, or 42.96 percent of the total number.

(*b*) Capsules with *more* than the median number of seeds bear altogether 20006.675 seeds, or 57.04 percent of the total number. In other words 50 percent of the capsules produce 57 percent of the seeds, or, put in still another way, one half of the heads bears 14 percent more of the total number of seeds than does the other half. This result is, of course, an obviously necessary arithmetical consequence of the symmetry of the capsule distribution, yet it is a point which is frequently overlooked. A symmetrical distribution of the individuals of a population with respect to some measure of fecundity does not mean that the contributions of these individuals to the next generation even before selection will be represented by a symmetrical distribution. The very fact that the original distribution is symmetrical necessitates the contrary relation.

The results with reference to the proportionate contributions of the different classes of heads to the total seed number show the conditions before elimination begins. Many of the 35,000 seeds were undoubtedly incapable of germination, and after germination many more would be eliminated before reaching maturity. As to the distribution of the eliminating factors acting in the case of the lotus we know nothing. What I wish to emphasize here is that out of the total number of seeds before elimination begins, 57 percent are the product of one half of the parent heads and only 43 percent the product of the other half.

The results of this study may be summarized briefly as follows:

(1) In the variation in respect to number of seeds per capsule *Nelumbium luteum* follows very closely the normal or Gaussian law of the distribution of errors.

(2) Place constants are given for the designated character in the form unit of Nelumbium growing in Sandusky Bay.

(3) From the fact that the frequency distribution of the capsules in respect to seed number is symmetrical about the mean it follows that one half of the whole number of capsules bears 14 percent more of the total number of seeds available for a new generation than does the other half of the capsules.

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THE CAUSES OF EXTINCTION OF MAMMALIA

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In studying the past history[1] of the Mammalia we find that in some cases the causes of the extinction are as obscure as in other cases they are obvious. I have thus been led to review the subject very carefully, gathering opinions and observations from various sources. I especially desire to arouse discussion and to receive criticisms and suggestions which will be warmly welcomed.[2]

History of Opinion

We find that while the main trend of present inquiry as to the external causes of extinction had been suggested by the middle of the nineteenth century, subsequent discoveries and observations furnish new and exact materials for induction both as to external and internal causes.

Cuvier, Lyell, Darwin.—The 'cataclysmal' views of Cuvier,[3] of wholesale destructions brought about by sudden and great geological changes, naturally gave way to the 'uniformitarian' views gradually developed from the time of Buffon to that of Darwin. The notions of the similarity of past and present causes, of the survival of the fittest, of internal causes of variation, development, and decline, gradually took their modern form. Whewell[4] clearly sets forth the opinions which developed between 1796 and

[1] Especially in connection with a monograph for the U. S. Geological Survey, entitled "The Titanotheres," which has been in preparation since 1900. This series of articles in the *Naturalist* will be embodied in somewhat modified form in the monograph.

[2] Address, Professor Henry Fairfield Osborn, American Museum of Natural History, New York.

[3] Cuvier, George. *Discours sur les révolutions de la surface du globe et sur les changements qu'ils ont produits dans le regne animal.* Paris, 1840. 1 vol. in 8vo.

[4] Whewell, —. *History of the Inductive Sciences*, vol. 3, 1837.

1837. Charles Lyell[1] gave the note for modern methods of research, greatly influenced Darwin, and perhaps exaggerated uniformitarianism.

In this very problem of extinction, however, uniformitarianism has a stout opponent in Henry H. Howarth. In his extremely interesting work *The Mammoth and the Flood* (London, 1878) he revives the theory of the destructive flood and marshals a vast number of facts to its support. "These facts," he observes (p. xvii), "I claim prove several conclusions. They prove that a very great catastrophe or cataclysm occurred at the close of the Mammoth period, by which that animal, with its companions, were [!] overwhelmed over a very large part of the Earth's surface. Secondly, that this catastrophe involved a very widespread flood of water, which not only killed the animals but also buried them under continuous beds of loam or gravel. Thirdly, that the same catastrophe was accompanied by a very great and sudden change of climate in Siberia, by which the animals which had previously lived in fairly temperate conditions were frozen in their flesh under ground and have remained frozen ever since."

The causes enumerated by Lyell in his later edition of the *Principles of Geology* after the publication of Darwin's *Voyage* and *Origin* are: (1) competition as affected chiefly by the introduction and extension of new forms, (2) agency of insects, *e. g.*, caterpillars, ants, locusts, in favoring or checking increase of plants and thus affecting the food supply of animals, (3) intimate reciprocal relations of animals and plants in the delicate balance of food supply, (4) disturbance of the equilibrium or balance of nature by the introduction of new insects, plants, vertebrated animals, (5) changes in physical geography affecting zoölogical and botanical provinces by new land or water connections, facilitating introduction of new competing forms, (6) causes especially potent in island life.

Referring to that subtle adjustment of the sum of all internal and external causes called the *balance of nature*, Lyell[2] observed: "Every new condition in the state of the organic or inorganic

[1] Lyell, Charles. *Principles of Geology*, 1872.

[2] Lyell, Charles. *Principles of Geology*, vol. 2, New York, 1872, pp. 455–456.

creation, a new animal or plant, an additional snow-clad mountain, any permanent change, however slight in comparison to the whole, gives rise to a new order of things, and may make a material change in regard to some one or more species. Yet a swarm of locusts, or a frost of extreme intensity, or an epidemic disease, may pass away without any great apparent derangement; no species may be lost, and all may soon recover their former relative numbers, because the same scourges may have visited the region again and again, at preceding periods. Every plant that was incapable of resisting such a degree of cold, every animal which was exposed to be entirely cut off by an epidemic or by famine caused by the consumption of vegetation by the locusts, may have perished already, so that the subsequent recurrence of similar catastrophes is attended only by a temporary change."

Even as a geologist Lyell was very cautious, certainly too cautious, in estimating the destructive influence of geologic and physiographic changes. In 1863 (*Antiquity of Man*,[1] p. 374), he observed:

"It is probable that causes more general and powerful than the agency of Man, alterations in climate, variations in the range of many species of animals, vertebrate and invertebrate, and of plants, geographical changes in the height, depth, and extent of land and sea, some or all of these combined, have given rise, in a vast series of years, to the annihilation, not only of many large mammalia, but to the disappearance of the *Cyrena fluminalis*, once common in the rivers of Europe, and to the different range or relative abundance of other shells which we find in the European drifts."

Charles Darwin[2] pursues a line of thought exactly prophetic to that of Lyell in discussing the Pliocene and post-Pliocene extinction of the large mammals of South America. He dismisses any catastrophic causes and in general attributes extinction to a *cessation of those world-wide conditions of life which were favorable to the larger quadrupeds* in Europe, Asia, Australia, North and

[1] Lyell, Charles. *Geological Evidences of the Antiquity of Man*, 2d ed., revised, 8vo, London, 1863, p. 374.

[2] Darwin, Charles. *Journal of Researches....Voyage of H. M. S. Beagle*, 8vo, 1834, pp. 169, 170.

South America. In South America and elsewhere (1) he does not favor the extreme theory of the destructive influence of the Glacial Epoch and he cites the supposed post-Glacial survival of Macrauchenia and Mastodon. "It could hardly have been a change of temperature," he observes (p. 170), "which at about the same time destroyed the inhabitants of tropical, temperate, and arctic latitudes on both sides of the globe." (2) He dismisses the possibility of extinction by man. (3) Also of an extended drought in South America, calling attention to the Pampean horse as an animal which could have survived a drought.

In seeking to establish a general law of extinction Darwin makes the following propositions: (1) the natural increase of animals is in geometrical ratio, while, (2) the food supply remains constant, thus (3) any great increase in numbers is impossible and must be checked by some means. (4) We are seldom able to state the cause of this check beyond saying that it is determined by some slight difference in climate, food, or the number of enemies. (5) We are, therefore, driven to the conclusion that causes generally quite inappreciable by us determine whether a given species shall be abundant or scanty in numbers. (6) Comparative rarity is the plainest evidence of less favorable conditions of existence. (7) Rarity frequently precedes extinction, and if the too rapid increase of species, even the most favored, is steadily checked, why should we feel such great astonishment at the rarity being carried a step farther to extinction.

These were Darwin's earlier views expressed in *The Voyage*. In *The Origin of Species* he discusses fully the checks to increase as follows: (1) climate as directly unfavorable, (2) as indirectly unfavorable by favoring other forms or by increasing the number of certain competitors. (3) Unchecked increase frequently followed by epidemics — possibly in part by facility of diffusion of parasites amongst the crowded animals. (4) Finally, since a large stock of individuals, relatively to the number of enemies, is absolutely necessary for the preservation of a species a diminished number would tend to extinction. (5) Any form (p. 133) which is represented by few individuals will run a good chance of utter extinction, during great fluctuations in the nature of the seasons, or from a temporary increase in the number of its enemies. (6) Diminution

in number presents less opportunity for producing favorable variations — hence rare species will be less quickly modified or improved within any given period.

Alfred Russell Wallace observes: "To discover how the extinct species have from time to time been replaced by new ones down to the very latest geological period, is the most difficult, and at the same time the most interesting problem in the natural history of the earth."[1] Also: "Whenever the physical or organic conditions change to however small an extent, some corresponding change will be produced in the flora and fauna, since, considering the severe struggle for existence and the complex relations of the various organisms, it is hardly possible that the change should not be beneficial to some species and hurtful to others."[2]

The majority of these speculations of these great naturalists have been abundantly confirmed. The opinions of many subsequent writers on this subject may be stated under their proper headings.

External Causes of Extinction

Physical Environment. Geological and Physiographic Changes

We may first consider those causes of extinction which originate with changes in the environment.

Changes of Land Masses and their Connections

Changes of land masses caused by elevation or subsidence operate indirectly through causing changes in all the physical conditions of climate, moisture, or dessication, temperature, etc.; also more directly in facilitating or cutting off migrations, in introducing new competition, etc.

Diminished or Contracted Land Areas.— The stable continents, North America and Africa, underwent slight fluctuations of land area in Tertiary times as compared with the highly unstable continents of Europe, of Australia, and of the southern half of South

[1] Wallace, Alfred R. *Natural Selection*, p. 14.
[2] Wallace, Alfred R. *Darwinism*, 1889, p. 115.

America. In Europe the varying coast lines, the insular conditions, the archipelagic surfaces are to be more seriously studied than they have been in connection with extinction, although it must be stated at once that the main phenomena of extinction in unstable Europe coincide with those in stable America.

Wallace discussed the extinction of the large Pliocene Australian mammals chiefly from this standpoint (see also p. 785). He (*Geog. Dist. Mam.*, 1876, vol. 1, pp. 158-159) attributed the Australian extinction chiefly to the possible glacial conditions and to the increased competition and struggle for existence caused by the progressively contracted land area due to subsidence.

The substitution of *insular* for *continental* conditions by subsidence has undoubtedly been a potent cause both of extermination in certain localities and of the survival of very primitive forms (Wallace), *e. g.*, Monotremata and Marsupialia in Australia. While the *contraction of land areas* may have resulted in general extinction, this has not yet been demonstrated.

Insular Conditions.— On islands we observe local dwarfing and extinction rather than the general extinction of a family or order which is our real subject. Of island life, so thoroughly studied by Wallace, it may be said at once that most of the causes both of survival and extinction which prevail on continents are *intensified on islands.* Wallace rightly attributes the survival of the Monotremata and Marsupialia to the practically insular condition of the Australian region. Lyell, Wallace, and others cite many instances of profound and rapid modifications caused by the introduction of new forms on islands.

PHYSICAL ENVIRONMENT. CHANGES OF CLIMATE

We have to consider temperature and moisture as brought about by geologic and physiographic changes, and also as affected by biotic changes or changes in the fauna and flora.

Increasing Cold

Influence of Secular Cold.— The effects of secular lowering of temperature must be analyzed with some care. At first sight

the theory of extinction through the direct action of cold is very simple, but it is found that some cases of extinction during the Glacial Period, of the horse in North America for example, do not admit of this explanation. It is more in accord with the facts to say that the Glacial Period originated certain new conditions of life which hastened extinction; these conditions relate to enforced migration, to overcrowding, to feeding, reproduction, mating, relations to enemies, deforestation, and other indirect results.

Protective Adaptation to Secular Cold.— Resistance to cold depends upon (*a*) internal heat-producing power which is a progressive adaptation of the higher Mammalia, (*b*) the acquisition of a warm external covering. The well known cases of adaptation to extreme cold among the elephants (*E. primigenius*, woolly mammoth), rhinoceroses (*R. tichorhinus*, woolly rhinoceros), horses (*E. przewalskii*), and certain northern ruminants, such as the camels and musk oxen, show that we must not assume that cold was in all cases the sole or direct cause of extinction.

Glacial and Post-Glacial Extinction. — Wallace observes: ". . . . We have proof in both Europe and North America, that just about the time these large animals were disappearing, all the northern parts of these continents were wrapped in a mantle of ice; and we have every reason to believe that the presence of this large quantity of ice (known to have been thousands of feet if not some miles in thickness) must have acted in various ways to have produced alterations of level of the ocean as well as vast local floods, which would have combined with the excessive cold to destroy animal life."[1] And again: ". . . . We can therefore hardly fail to be right in attributing the wonderful changes in animal and vegetable life that have occurred in Europe and North America between the Miocene period and the present day, in part at least, to the two or more cold epochs that have probably intervened. These changes consist, first, in the extinction of a whole host of the higher animal forms; and, secondly, in a complete change of types due to extinction and emigration, leading to a much greater difference between the vegetable and animal forms of the Eastern and Western hemispheres than before existed."[2]

[1] *Geographical Distribution of Animals*, vol. 2, p. 151.
[2] Wallace, A. R. *Island Life*, 1881, p. 117.

Certainly the most direct instance of a great extinction of quadrupeds contemporaneous with a secular change of climate is that of the Glacial Period in the entire northern hemisphere. The close of the Pliocene or beginning of the Pleistocene found North America peopled with the following kinds of great quadrupeds, all of which disappeared during the Ice Age.

Artiodactyla	Camelidæ	Camels
		Llamas
Perissodactyla	Equidæ	Horses
	Tapiridæ	Tapirs
Proboscidea	Mastodontinæ	Mastodons
	Elephantinæ	Elephants
Edentata	Gravigrada	Giant Sloths
		Megalonyx
		Megatherium
		Paramylodon
	Glyptodontia	Glyptotherium

Numerical Diminution of Camelidæ.—The Glacial Period was heralded by increasingly severe winters and cold waves. The observations of Prichard in Patagonia throw a light on the numerical diminution of the Camelidæ.

"Around the lake lay piled the skulls and bones of dead game, guanaco (*Lama huanachus*) and a few huemules (*Furcifer chilensis*). These animals come down to live on the lower ground and near unfrozen water during the cold season, and there, when the weather is particularly severe, they die in crowds. We saw their skeletons, in one or two places literally heaped one upon the other" (*Through the Heart of Patagonia*, 1902, p. 132). "Again we came upon a second death-place of guanaco, which made a scene strange and striking enough. There cannot have been less than five hundred lying there in positions forced and ungainly as the most ill-taken snapshot photograph could produce. Their long necks were outstretched, the rime of the weather upon their decaying hides, and their bone-joints glistening through the wounds made by the beaks of carrion-birds. They had died during the severities of the previous winter, and lay literally piled one upon another" (*op. cit.*, p. 189). "The meaning of this I gathered from Mr. Ernest Cattle. He told me that in the winter of 1899 enor-

mous numbers of guanaco sought Lake Argentino, and died of starvation upon its shores. In the severities of winter they seek drinking-places, where there are large masses of water likely to be unfrozen. The few last winters in Patagonia have been so severe as to work great havoc among the herds of guanaco" (*op. cit.*, p. 255).

Deforestation and Secular Cold.— After considering the conditions in Alaska, Mr. A. G. Maddren[1] summarizes his conclusions as follows: "I. That while remnants of the large Pleistocene mammal herds may have survived down to the Recent period and in some cases their direct descendants, as the musk-ox, to the present, most of them became extinct in Alaska with the close of the Pleistocene.

"II. The most rational way of explaining this extinction of animal life is by a gradual changing of the climate from more temperate conditions permitting of a forest vegetation much farther north than now, to the more severe climate of today, which subduing the vegetation and thus reducing the food supply besides directly discomforting the animals themselves, has left only those forms capable of adapting themselves to the Recent conditions surviving in these regions to the present."

Influence of Cold and Snow on Food Supply and Choice of Food. — The deaths of great numbers of animals from hunger or starvation through the covering of food during the winter season under heavy layers of snow are commonly observed among the large herds of some of the domesticated horses and cattle on the Western plains. In fact, it is most probable that during the glacial period the great winter snow blankets covering the natural food rather than the actual influence of the cold itself, was the chief cause of extinction.

Under these conditions horses are driven to food, such as the branches of willows, which is very deleterious to them. Under the influence of hunger cattle and sheep also will feed eagerly and indiscriminately on plants which may be injurious to them or to their young, as recorded by Chestnut and others in the United

[1] Maddren, A. G. "Smithsonian Exploration in Alaska in 1904, in Search of Mammoth and other Fossil Remains." *Smiths. Misc. Coll.*, vol. 49, p. 65.

States Agricultural Department. The indirect results of hunger may be, therefore, quite as effective as actual starvation.

Animals vary greatly in adaptability to new conditions caused by prolonged cold and heavy snowfall. Horses remove snow even to depths of three or four feet and find food to carry them through the winter, while cattle under the same conditions starve.

An interesting instance of the effects of a temporary lowering of temperature in a subtropical region is that cited by Bangs of the influence of an unusual cold wave in the habitat of one of the Sirenia (*Manatus manatus*) in the rivers of Florida in the winter of 1895. The author observed that an unusual cold wave cut down all the leaves of the mangrove, a favorite food of the manatee at certain seasons. This was followed by a marked numerical diminution of the manatee.[1]

Dangers of Numerical Diminution and Diminished Herds.— While distinction must be drawn between actual extinction and a *temporary diminution* in numbers caused, for example, by cold waves, prolonged or repeated droughts, floods, epidemics, and other unfavorable conditions of life, it is very important to observe, as suggested by Darwin, that diminution in numbers may lead to extinction in certain cases. For example, a herd of animals may be reduced to the danger point in numbers where they can no longer protect their young. Director Bell of the Canadian Geological Survey believes that the small herd of Woodland Bison of British Columbia, now thoroughly protected by the government, will be destroyed gradually through the killing of the calves by wolves, the bulls not being sufficiently numerous to protect the calves.

Diminished Herds and Inbreeding.— Diminished herds in restricted regions may also disappear through too close inbreeding. On this familiar subject see Gerrit S. Miller's[2] paper "Fate of the European Bison Herd," in which the author shows the possibly fatal influence of inbreeding on diminished herds, although it must be pointed out that the animals are protected and are thus *living under unnatural conditions.*

[1] Mr. C. H. Townsend, from observations in the New York Aquarium, is inclined to attribute this diminution to the respiration of the frosty air.

[2] Miller, Gerrit S., Jr. "The Fate of the European Bison Herd." *Science*, n. s., vol. 4, no. 99, Nov. 20, 1896, pp. 744–745.

In a paper entitled "Das allmähliche Aussterben des Wisents (*Bison bonasus* Linn.) im Forste von Bjelowjesha",[1] Mr. Eugen Büchner gives a detailed history of the bison herd in the Bieloviejsha (or Bialowitza) forest, Province of Grodno, in Lithuania, Russia, during the present century. "A careful study of the breeding habits of the bison in the Bieloviejsha forest and elsewhere leaves no room for doubt that the present slow rate of reproduction is an abnormal condition, and that to it is due the rapid approach of the extinction which is the certain fate of the herd under consideration. This diminished fertility the author regards as a stigma of degeneration caused by in-breeding.... Another indication of the degenerate condition of the Bieloviejsha herd is seen in the great excess of bulls, which probably outnumber the cows two to one. This is doubtless a result of in-breeding, for Düsing (*Jen. Zeits. f. Naturw.*, Bd. xvii, p. 827, 1884) has shown that close in-breeding, like a reduced condition of nutrition, is favorable to the production of an excess of males.... In conclusion, the author considers that his studies of the history of the Bieloviejsha bison leave scarcely room for doubt that in-breeding is the cause of the final extinction of most large mammals. Inbreeding must begin and lead gradually but certainly to the extinction of a species when it, through any cause, has become so reduced in numbers as to be separated into isolated colonies."

Influence of Cold during the Reproduction Period.— Exceptional cold waves or unusually prolonged cold seasons may cause a temporary loss of food supply or cause the death of the young, which in northern latitudes are usually born in spring. The diminution or loss of young from this cause might act as the first of a series of destructive effects of a progressive secular change. These may be summarized as follows from actual zoölogical observations[2] among the Cervidæ: (*a*) disturbed conditions during the conjugation (pairing, mating, rutting) period; (*b*) enfeebled (through hunger) condition of females during parturition period; (*c*) severe weather conditions, ice-storms, crusted snow, prolonged

[1] Büchner, Eugen. *Mém. Acad. Impér. des Sci. de St. Pétersbourg,* vol. 3, no. 2, 1895, p. 1–30.

[2] Communicated by Mr. Madison Grant, Secretary of the Zoölogical Society of New York.

wet and sleet at time of birth; (*d*) bulls unable to protect herds; (*e*) cows unable to protect young from Carnivora through starved condition, or abandoning them when attacked by wolves; (*f*) enfeebled and unprotected condition of quadrupeds favorable to increased food supply and consequent multiplication of cursorial and other Carnivora, especially Canidæ and Felidæ.

These zoölogical observations are to a certain extent borne out in paleontology by Leith Adams' (*British Fossil Elephants*, 1879, part 2, p. 98) observations of the exceptionally large number of milk teeth of elephants found in certain Pleistocene deposits, which appears to indicate a high mortality of the young.

Temperature Control of Fertility and Reproduction.— Merriam[1] has directed attention to one of the physiological effects of a lowering of temperature, namely, its influence upon diminished or increased fertility and the rate of reproduction in what he has called the 'law of temperature control'. This he has stated as follows: temperature by controlling reproduction predetermines the possibilities of distribution; it fixes the limits beyond which species cannot pass; it defines broad transcontinental barriers within which certain forms may thrive if other conditions permit, but outside of which they cannot exist, be the other conditions never so favorable, (because the sexes are not fertile).

(1) *Temperature.* In discussing how species are checked in their efforts to overrun the earth Merriam points out that more important than geographic barriers are the *climatic barriers* (as observed by Humboldt), and of these that temperature is more important than humidity. First, in 1892, this author attempted to show (*Proc. Biol. Soc. Washington*, vol. 7, April, 1892, pp. 45, 46) that the distribution of terrestrial animals is governed less by the yearly isotherm or mean annual temperature than by the total rather than the mean temperature during the period of reproductive activity and of growth (adolescence). This reproductive period in the tropics extends over many months or nearly the whole year, and within the Arctic Circle and summits of high mountains is of two months or less duration. Later, in 1894, results which

[1] Merriam, C. Hart. "Laws of Temperature Control of the Geographic Distribution of Terrestrial Animals and Plants." *Nat. Geogr. Mag.*, vol. 6, Dec. 29, 1894.

Merriam obtained from extensive comparison of temperatures and distribution justified the belief that animals and plants (Lower Austral and tropical types coming from the South) are restricted in northward distribution by the total quantity of heat during the season of development and reproduction. Conversely animals and plants (Upper Austral, Transition, and Boreal types coming from the North) are restricted in southward distribution by the mean temperature of a brief period covering the hottest part of the year. Thus in the Transition Zone, Boreal and Austral types mingle in the equable climate of the Pacific coast of California while they are sharply separated by the inequable extremes of cold and heat of the interior continental plateau.

(2) *Humidity*, observes Merriam, is a less potent factor than temperature in limiting the distribution of the Mammalia of North America.[1] (*a*) Many genera adapted to certain restrictions of temperature zones range east and west completely across the American continent inhabiting alike the humid and arid subdivisions but no genus adapted to certain restrictions of humidity ranges north and south across the temperature zones. (*b*) Thus humidity governs the details of distribution of a few species of mammals within the temperature zones.

Lowering of Temperature and Diminished Fertility as a Cause of Extinction.— Since the favorable influence of high mean temperature on fertility and reproduction is well illustrated in the reproductive organs of birds and in the early age of reproduction and increased fertility of the human species toward the equator, and since there exist these low-temperature barriers to reproduction, it is highly probable that a secular lowering of temperature may have repeatedly been a cause of extinction in the earth's history; that certain mammals may have resisted exposure to cold or discovered new forms of food and yet suffered extinction through the subtle inhibition of fertility and reproduction.

Increasing Moisture

Influences of Increased Rain Supply.— Besides the changes in

[1] This would not be true of Africa, of Central America, or other tropical countries where certain insect and disease barriers exist which are favored by moisture.

plant food which are brought about by diminished moisture, as indicated below, there are the effects of increased moisture which may be equally if not more important. Dry or moderately dry conditions, provided they are not too extreme, are generally more favorable to quadrupeds than moist conditions. The plains and forest regions most densely populated with quadruped life, such as those of the African plateau, are regions of moderate rainfall and even of prolonged summer droughts. The regions least densely populated are regions of heavy rainfall and most dense forests and vegetation, such as those of the equatorial belt of South America or the Congo region of Africa. We observe that:

(1) Increased rainfall may diminish the supply of harder grasses to which certain quadrupeds have become thoroughly adapted.

(2) Increased rainfall may introduce new poisonous or deleterious plants (see p. 790).

(3) It may be the means of introducing new insect and other pests and new insect barriers.

(4) It may be the means of introducing new protozoan diseases, and new insect carriers of diseases.

(5) It may be the means of erecting new forest barriers or new forest migration tracts for certain Carnivora. It follows that periods of secular increasing moisture such as the early Pleistocene of the northern hemisphere is supposed to have been, may have been very unfavorable to certain large quadrupeds, even prior to the advent of extreme cold.

Insect Barriers and Moisture.— It is a matter of universal observation that in tick- or insect-infested countries, generally, dry seasons result in the reduction, moist seasons in the increase of diseases. Dry localities are favorable; moist localities are unfavorable.

Thus A. E. Shipley observes of the tse-tse fly, in his interesting address[1] that its "northern limit corresponds with a line drawn from the Gambia, its southern limit is about on a level with the northern limit of Zululand. Most writers agree that the tse-tse is not found in the open veldt, that it must have cover. Warm, moist, steamy hollows, containing water and clothed with forest growth are the haunts chosen."[1]

[1] Shipley, Arthur E. "Insects as Carriers of Disease." *Nature*, vol. 73, no. 1888, Jan. 4, 1906, pp. 235–238.

Decreasing Moisture. Secular Desiccation

Secular desiccation has been the fate of portions of three great continents, and on each continent we observe a general concomitant modification and extinction of certain kinds of quadrupeds. The great regions of the world where decreasing moisture has introduced a series of changes ending in the extinction of a great number of quadrupeds are:

(1) North America, Western Plains Region, Arid Plateau and Mountain Region beginning in Oligocene times.

(2) South America, Patagonia and Pampean Region, beginning in late Pliocene times.

(3) North Central Africa, the Fayûm district beginning in Oligocene times.

(4) Central Australia, beginning in Pleistocene times.

The writings of American paleontologists, also of Stirling, of Andrews, and of Ameghino, describe faunæ adapted to much moister conditions than those which prevail at present. We observe that decreasing moisture:

(1) Changes the character of the food supply. Diminution of softer and more succulent vegetation, increase of harder and more resistant vegetation.

(2) Increases length and severity of the dry season.

(3) Removes forest barriers and admits new competitors.

(4) Reduces the water supply and eliminates animals incapable of traveling long distances for food and water.

(5) Favors grazing quadrupeds and eliminates browsing and forest-living quadrupeds.

Prolonged or increasing droughts entirely disturb the balance of nature; they compel migrations; they expose quadrupeds to Carnivora by driving them to restricted water pools. They favor quadrupeds able to dispense with a daily supply of water.

Secular Desiccation and Vegetation.—The indirect influences of secular changes of climate on quadrupeds are apparently quite as important factors in extinction as the direct, namely, changes in vegetation due to diminution of moisture, which render certain types of quadrupeds which were perfectly adapted to one kind of

plant food, largely or wholly inadapted to the new or altered kinds of food. This we shall show was probably the most potent factor in the extinction of the Titanotheres, of the Chalicotheres, in fact of all the quadrupeds with short-crowned molar teeth, adapted to browsing habits.

The correlation between an initial change of climate and the consequent diminution of the softer kinds of vegetable food and increase of the harder kinds, such as grasses, followed by the extinction of a very large number of Herbivora, was first thoroughly worked out in an epoch-making memoir of Waldemar Kowalevsky in 1873.

Droughts and Numerical Diminution.— Darwin[1] describes the devastating effects of the great drought in the Pampas between 1827 and 1830 in which great numbers of birds, wild animals, cattle, and horses, perished from want of food and water. The cattle perished by thousands on the muddy banks of the Parana River. Similarly Azara describes the horses perishing in large numbers in the marshes.

Increasingly prolonged summer droughts were characteristic of the late Miocene and Pliocene of Europe, and we are beginning to accumulate evidence that the same conditions prevailed in North America.

Influence of Droughts in Central Africa.— The influence of the gradual decrease of moisture in a country is clearly illustrated in the conditions which prevail in the African continent to-day, as observed by such writers as Gregory,[2] Foa, and Schillings. Thirst, like hunger, first drives quadrupeds to take extreme risks, which they would absolutely avoid during natural conditions. The drinking-places or water-pools during long seasons of drought become fewer in number and more widely separated, and large animals driven to them by thirst are more readily attacked and killed by Carnivora. The pools become separated by distances of thirty and forty miles, thus necessitating long excursions to and from the various feeding places, in which the quadrupeds are

[1] Darwin, Chas. *Journal....Voyage of H. M. S. Beagle around the World*, p. 128–130.

[2] Gregory. *The Great Rift Valley*....8vo. London, 1896.

again exposed to attack. Finally some of the pools dry up entirely and, as observed by Gregory, (p. 268): "Here and there around a water hole we found acres of ground white with the bones of rhinoceroses and zebra, gazelle and antelope, jackal and hyena ....all the bones were there fresh and ungnawed...." These animals, which had not migrated, had "crowded around the dwindling pools and fought for the last drops of water."

Such perishing of animals in great numbers from thirst would bring about the condition of *diminished herds* spoken of above as the final cause of extinction through inability to protect the young.

Alkali and Salt Deposits.— One effect of increasing desiccation is the increased number of alkali lakes, licks, and springs, and other localities of salt deposits. Alkali is much sought by certain wild animals as a substitute for salt. Western stock-raisers disagree as to the effects of alkali upon sheep and cattle, some believing that it cannot take the place of salt. Chestnut (1901, p. 20) notes that alkali may possibly predispose to the 'loco habit,' the eating of a narcotic weed (see p. 791). When domesticated animals are not salted regularly they soon discover localities where large quantities of alkali are found in the soil and visit such places frequently for the purpose of eating this alkali soil (Chestnut, 1901, p. 87).[1]

Desiccation and Extinction in Central Australia.— Wallace's opinion as to Australian extinction has been cited more with reference to the effect of Glacial-Epoch conditions and continental contraction in general than as to the special causes of extinction in Australia.

More recent research as set forth by the geologist Professor Tate,[2] the zoölogists Hedley[3] and Baldwin Spencer, show that in Pliocene times heavy rainfall or pluvial conditions, great inland

[1] Chestnut, V. K., and Wilcox, E. V. "The Stock-poisoning Plants of Montana: A Preliminary Report." *U. S. Dept. of Agric., Div. of Botany,* bull. 26, 1901.

[2] "On the Influence of Physiographic Changes in the Distribution of Life in Australia." *Austr. Ass. Adv. Sci.,* vol. 1, pp. 312–325, 1889. Quoted by Baldwin Spencer. *Through Larapinta Land; A Narrative of the Horn Expedition to Central Australia,* Part 1, p. 159, 1896.

[2] "The Faunal Regions of Australia." *Austr. Ass. Adv. Sci. Adelaide,* 1893.

seas or freshwater lakes (first surmised by Stuart) favored the development of large marsupials. Conversely the rise of an eastern coastal range was followed by diminished rain supply and progressive desiccation of the interior region.

Spencer observes:[1] "The larger forms now extinct, such as species of Diprotodon, Nototherium, Phascolonus, Macropus, Protemnodon, etc., reached their greatest development in Pliocene times and were characteristic of the eastern interior, spreading southward round the western end of the Dividing Range into Victoria. They do not seem to have reached the eastern coastal district. . . . . In Post-Pliocene times, with the increasing desiccation of the whole central area they became extinct, though this extinction cannot be attributed wholly to the drying up of the land, because in certain parts, such as Western Victoria, to which they reached, the state of desiccation did not supervene; but at the same time it may perhaps be justly argued that the desiccation of the vast area of the interior was the largest factor in their extinction."

The discovery (1892) of the great Lake Callabonna bone deposit in the interior of South Australia abundantly confirms the 'desiccation' theory. Dr. E. C. Stirling[2] describes this remarkable deposit as follows: —

"There is, however, compensation for the unpromising physical features of Lake Callabonna in the fact that its bed proves to be a veritable necropolis of gigantic extinct marsupials and birds which have apparently died where they lie, literally, in hundreds. The facts that the bones of individuals are often unbroken, close together and, frequently, in their proper relative positions (*vide* pl. A, fig. 3), the attitude of many of the bodies and the character of the matrix in which they are embedded, negative any theory that they have been carried thither by floods. The probability is, rather, that they met their death by being entombed in the effort to reach food or water, just as even now happens in dry

[1] Spencer, Baldwin. *Report of the Horn Expedition to Central Australia. Summary of the Zoological, Botanical and Geological Results of the Expedition*, 1896, p. 183.

[2] Stirling, E. C. "Fossil Remains of Lake Callabonna." *Mem. Roy. Soc. of South Australia*, vol. 1, pt. 2, pp. ii–iii.

seasons, to hundreds of cattle which, exhausted by thirst and starvation, are unable to extricate themselves from the boggy places that they have entered in pursuit either of water or of the little green herbage due to its presence. The accumulation of so many bodies in one locality points to the fact of their assemblage around one of the last remaining oases in the region of desiccation which succeeded an antecedent condition of plenteous rains and abundant waters. An identical explanation has been suggested by Mr. Daintree[1] in his 'Notes on the Geology of the Colony of Queensland.'"

Living Environment. Plant Life

Under climate we have considered the relations of cold, heat, moisture, and desiccation to hunger, thirst, the feeding and migrating habits of animals. We may now look at the food supply of the Herbivora in relation only to *unusual conditions of life.*

Forestation, Deforestation, and Reforestation.— Forests furnish the necessary conditions of life of certain quadrupeds, especially of the browsers and of the Proboscidia. Among Artiodactyla the deer, among Perissodactyla the tapirs are typical forest animals. Conditions, therefore, which cause deforestation would become a means of extinction; such conditions are (*a*) intense cold and heavy snow capping, (*b*) intense dryness, (*c*) destruction of young trees by the smaller browsing animals. It is probable that the interior of Australia and the Pampean region of South America were in Pliocene and early Pleistocene times partially covered with forests. It is certain that the Holarctic region or circumpolar belt was forested in the early Pleistocene. Our western arid region was extensively forested at one period. Several of the smaller islands of the Mediterranean have been deforested. Reforestation would confine and limit the desert and plains types. Progressive moisture and reforestation would be very unfavorable to the horse (see Morris, 1895, p. 261). Thus both migration barriers and migration tracts are formed by forests.

[1] *Quart. Journ. Geol. Soc.*, vol. 28, 1872, p. 275.

A New or Altered Food Supply

Poisonous Plants.—Plants which are fatal to some Herbivora are innocuous to others. Linnæus in his *Tour in Scania* tells us, as cited by Lyell [1] "that goats were turned into an island which abounded with the *Agrostis arundinacea*, where they perished by famine; but horses which followed them grew fat on the same plant. The goat, also, he says, thrives on the meadow-sweet and water-hemlock, plants which are injurious to cattle." [2]

We must be extremely cautious not to substitute artificial conditions or those brought about by the agency of man for purely natural conditions. In speaking of the deaths caused by the twenty-five species of stock-poisoning plants found in Montana, Chestnut [3] observes: "But all these causes operate much less effectively against buffaloes and other ruminants in the wild state for, in the first place, being bred there under perfectly natural conditions, and being abundantly able to roam over long distances in search for food and water, they naturally reject all but the best and most wholesome diet. Then in the winter they migrate to the south, where the conditions for their existence were more favorable....Besides, it would require a large quantity of any of the common poisonous plants to kill an animal of such size."

Observations in South Africa [4] give similar results. The 'chinkerinchee' plant (Ornithogalum) is poisonous to horses, and one of the ragworts (Senecio) is an irritant causing cirrhosis of the liver in cattle and horses. Other plants which give trouble are tulps (species of Moræa). The losses are chiefly among cattle not accustomed to the country, or amongst very hungry trek cattle.

It is true, first, that animals generally but not invariably learn to avoid poisonous plants, second, that they become more or less immune to their deleterious effects, third, that often it is solely

[1] *Principles of Geology*, vol. 2, p. 440, 1872.

[2] *Ibid.*, vol. 7, p. 409.

[3] "Some Poisonous Plants of the Northern Stock Ranges." *Yearbook Dept. Agriculture for 1900, Washington*, pp. 308–309.

[4] Kindly communicated by Charles P. Lounsbury, of the Department of Agriculture, Cape of Good Hope. See *Agricultural Journal*, February, 1906.

the influence of hunger which drives them to eat poisonous plants. This justifies the consideration of plants under unusual conditions of life among the possible causes of extinction. The presence of molds and smuts which appear on the Gramineæ, the introduction and spread of certain narcotic plants, the influence of ergot in causing diseases of the hoof, the relation of poisonous plants to increased or diminished rainfall, the introduction of certain poisonous plants which while not injuring the parent affect and frequently kill the suckling young may be considered. Lambs are frequently killed by sucking milk from animals which had fed on the death camas, *Zygadenus venenosus*.[1]

Dangers Heightened by Harsh or Unusual Conditions of Life

Poisonous plants are widely distributed. Under the unnatural conditions of extreme cold, drought, enforced migration, starvation, etc., it is not impossible that they may have exerted some influence especially on *diminishing herds*. The following observations are chiefly brought together from the papers of Dr. V. K. Chestnut of the U. S. Agricultural Bureau. This author states in a letter dated July 9, 1902: "So far as my observations have extended the chief circumstance leading to death from poisonous plants is an irregularity of the food supply caused by more or less unusual conditions. It does not seem reasonable to suppose that wild animals are frequently poisoned in their native grazing grounds. Sudden disasters, however, might drive them from their feeding grounds into pastures quite unfamiliar to them, where they would undoubtedly be more or less at a loss to distinguish between poisonous and non-poisonous plants."

The following observations (*a, b, c*) apply to domesticated Herbivora.

(*a*) *Varying Effects of Wet and Dry Months.*—Chestnut ("Stock-Poisoning Plants of Montana" 1901, p. 19) observes that the majority of plants known to be especially poisonous during the wet months are so shriveled and dry in the dry months as to be

[1] Chestnut, V. K., and Wilcox, E. V. *Stock Poisoning Plants of Montana.* p. 61.

absolutely unpalatable. Sheep owners have accordingly found mountain ranges which are extremely dangerous for sheep during the wet months of early summer, quite safe during the months from July to September inclusive. Similarly, during the wet season and when feeding immediately after heavy rainstorms domesticated animals are more apt to pull up the roots of plants than when the ground is dry (Chestnut, 1901, p. 26), and, as is well known, in the case of many poisonous plants it is the roots which chiefly contain the active principle.

(*b*) *Fatal Effects of Snowstorms.*—After heavy snowstorms when the grass is covered by snow it often happens that only the taller species of plants are exposed (Chestnut, 1901, p. 27). In such cases the poisonous larkspurs (*Delphinium glaucum*) are greedily eaten by cattle, which would otherwise avoid these plants. This tendency is increased by the fact that ruminants do not feel at ease so long as the stomach is not full and are inclined to eat anything in sight after a snowfall. In seasons of drought certain poisonous leguminous plants remain green and tempting after the grasses have become thoroughly dried. Under these conditions cattle on the range are known to take the loco and lupin (Chestnut, 1901, p. 29).

(*c*) *Fatal Effects of Enforced Migration.*—It is observed (Chestnut, 1901, p. 21) among domesticated animals that when feeding quietly on the range they exercise considerable choice in the selection of forage plants, but when being driven six or eight miles a day they are frequently forced by hunger to bite off almost all kinds of plants which grow along their course. Enforced migration among wild animals might similarly cause them to become less fastidious about food.

Dangerous Plants Favored by Moisture

Poisonous Plants of Montana.—The chief poisonous plants of the Montana stock ranges (Chestnut, 1901) are: the death camas (Zygadenus), favored by moderate moisture and taken by sheep; the "tall larkspur" (*Delphinium glaucum*), favored by moderate moisture, taken by cattle; the "purple larkspur" (*D. bicolor*), taken by sheep; the water hemlock (Cicuta), found along water

courses, taken by cattle and sheep; the white loco (Aragallus), taken by horses, sheep, and cattle. Lupines (Lupinus) in certain stages of growth are poisonous to sheep. Ergot (*Claviceps purpurea*), occurs in Montana on a variety of grasses, and is occasionally poisonous to horses and cattle, producing a disease of the limbs. On a large ranch of Wyoming, ergot is reported (Walter Granger, letter, 1904) to have appeared as *a result of irrigation* rendering a large tract fatal to horses and cattle by causing a disease of the hoofs.

A leguminous plant of Egypt, *Lotus arabicus*, recently investigated by Dunstan and Henry,[1] as a growing plant, is quite poisonous to horses, sheep, and goats. Its seeds when ripe are commonly used as fodder. It contains a glucecoid termed 'lotusin,' which is poisonous when taken into the stomach (Chestnut, 1902).

Narcotic Plants.— Among narcotic plants 'loco weeds' are the most interesting. 'Loco' is a Spanish word meaning mad or crazy, and is applied in northern Mexico and southern United States to certain plants which so affect the brain of animals as to give them all the symptoms of brain disease. As described in the important papers of Chestnut[2] the weeds called 'loco' belong to genera of the bean family. "For many years," this writer observes, "a disease called loco, affecting cattle, horses, and sheep, has been generally known to the stockmen of the western ranges. This disease has most commonly been attributed to the action of certain plants, more rarely to that of alkali. Several species of plants have been suspected of producing the loco condition in animals and have been called loco plants or loco weeds and also crazy weeds from the nature of the disease. Nearly all of the plants which have been considered loco weeds belong to two genera of the pea family, Astragalus and Aragallus. These genera are represented by numerous species on the Western stock ranges.... (p. 87)....From a general description given of the loco disease it is apparent that this condition might very justly be termed a perverted appetite....The horse and the sheep are the animals

[1] "Problems in the Chemistry and Toxicology of Plant Substances." *Science*, n. s., vol. 15, no. 391, June 27, 1902, pp. 1016–1028.

[2] Chestnut, V. K. "Preliminary Catalogue of Plants Poisonous to Stock." *Ann. Rep. Bur. of Anim. Indus., 1898*, pp. 403, 404.

which are most frequently affected by loco disease. Cattle occasionally acquire the loco habit, but the cases are comparatively rare. In certain parts of Montana the habit became so widespread among horses that the raising of them was abandoned until the locoed animals were disposed of and other horses which had not the loco habit had been imported" (p. 89). "During the progress of field work in Montana in 1900, about 650 locoed sheep and 150 locoed horses were seen"[1] (p. 90).

Mechanically Dangerous Plants.—There occur in Montana occasional losses of stock from plants acting mechanically. For example, the sharp-barbed awns of the porcupine grass (*Stipa spartea*) and squirreltail (*Hordeum jubatum*) when the plants are maturing, separate, and entering the mouth, throat, eyes, and ears of stock, affect the tissues and give rise to ulcers which cause intense suffering and necessitate killing.[2] Similarly the corn-stalk disease is sometimes attributed to malnutrition or impaction of the alimentary canal.

In this connection may also be cited an observation recorded by Thistleton-Dyer[3] which happens to bear upon the life of goats. "The introduction of the sweet briar into New South Wales, Australia, in many parts of which it is naturalized, affords a striking illustration of the mode in which the balance of nature may be disturbed in a wholly unforeseen way.... The fruit of the sweet briar (*Rosa rubiginosa*) consists of a fleshy receptacle lined with silky hairs which contains the seed-like carpels..... The hairy linings of the fruit caused the death of a number of goats by forming hairy calculi, which mechanically occluded the lumen of the bowels. These goats were put on the land with the idea that they would eat down the briars and ultimately eradicate them, but the briars came out best and eradicated the goats. The cattle running on the land are also very fond of the briar berries, and

[1] Chestnut, V. K., and Wilcox, E. V. "The Stock-Poisoning Plants of Montana: A Preliminary Report." *U. S. Dept. of Agric. 1901*, bull. 26, pp. 87–90.

[2] Chestnut, V. K. "The Stock-Poisoning Plants of Montana. A Preliminary Report." *U. S. Dept. of Agric., 1901*, bull. 26, pp. 50–51.

[3] "The Sweet Briar as a Goat-Exterminator." *Nature*, vol. 66, no. 1697, May 8, 1902, p. 31.

from time to time one will die, and on *post mortem* [examination] no pathological changes can be found in any of the organs, nor do the hairy calculi appear in them, although their various stomachs are one mass of the briar seeds."

Living Environment. Insect Life

The features of physical environment such as moisture and desiccation, forestation and deforestation, heat and cold, cannot be considered by themselves or solely in relation to plant life but in relation to the insect life which they condition and which indirectly becomes the barriers and even the exterminators of mammalian life.

We may first consider the influence of the introduction into habitual feeding grounds of various forms of insect life which render these grounds practically uninhabitable and either kill or drive the animals out. Thus Wallace[1] observes: "The next case I will give in Mr. Darwin's own words: 'In several parts of the world insects determine the existence of cattle. Perhaps Paraguay offers the most curious instance of this; for here neither cattle nor horses nor dogs have ever run wild, though they swarm southward and northward in a feral state; and Azara and Rengger have shown that this is caused by the greater numbers, in Paraguay, of a certain fly which lays its eggs in the navels of these animals when first born. The increase of these flies, numerous as they are, must be habitually checked by some means, probably by other parasitic insects. Hence, if certain insectivorous birds were to decrease in Paraguay, the parasitic insects would probably increase; and this would lessen the number of the navel-frequenting flies — then cattle and horses would become feral, and this would greatly alter (as indeed I have observed in parts of South America) the vegetation: this again would largely affect the insects, and this, as we have just seen in Staffordshire, the insectivorous birds, and so onward in ever-increasing circles of complexity. . . .'"

The two-horned rhinoceros (*R. bicornis*) of Africa as well as

[1] Wallace, Alfred R. *Darwinism*, 1889, p. 19.

some members of the antelope family are well known to be protected from insects by birds (see Millais's *Breath of the Veldt*, and other works). Anyone who has watched the sufferings of cattle and horses from flies knows that insects may become an important factor in expelling animals from a certain country to which they are naturally adapted by their tooth and foot structure.

Ticks.— Ticks, even when non-infection-bearing, form absolute and effective barriers to the introduction of quadrupeds into certain regions. In certain forested portions of South and Central America they endanger human life. In certain regions of Africa ticks are practically fatal to horses; as observed by Dr. D. G. Elliot thousands of ticks would sometimes gather on a horse as a result of a single night's grazing. The mane especially serves to collect these pests. Thus the falling mane of the northern horse is distinctly disadvantageous as compared with the upright manes of the asses and zebras. Ticks are capable of driving certain types of animals entirely out of a country and of indirectly causing certain modifications of the hair and epidermis.

Frontal Air Sinuses.— Larvæ invading the frontal sinus of the skull are not to be left out of account among the possible causes of elimination. An old trapper and close observer in British Columbia, Mr. Charles Smith, informs me that both the wild sheep of the region (*Ovis montana*) and the wapiti (*Cervus canadensis*) are seriously affected and sometimes killed by inflammation caused by these larvæ. The over-crowded caribou of Labrador and Newfoundland suffer from a fly which lays its eggs in the nostril passages.

In certain of the Eocene Titanotheres, in Dolichorhinus especially, the frontal air sinuses communicate with sinuses extending completely back to the occiput. The invasion of such sinuses by larvæ would undoubtedly be very harmful if not fatal.

Insects and the Food Supply.— The periodic devastations of certain insects especially those caused by locusts as cited by Lyell in Europe, Arabia, India, and Northern Africa, are quite sufficient to cause the extinction of certain species. As Lyell concludes:[1] "The occurrence of such events at certain intervals, in hot countries,

[1] Lyell, C. *Principles of Geology*, vol. 2, 1872, p. 445.

like the severe winters and damp summers returning after a series of years in the temperate zone, may affect the proportional numbers of almost all classes of animals and plants, and probably prove fatal to the existence of many which would otherwise thrive there; while, on the contrary, the same occurrences can scarcely fail to be favourable to certain species which, if deprived of such aid, might not maintain their ground."

(*To be continued*)

A PRELIMINARY STUDY OF THE FINER STRUCTURE OF ARCELLA

JOSEPH A. CUSHMAN AND WILLIAM P. HENDERSON

THIS study of Arcella is based upon two species, *Arcella vulgaris* Ehrenberg and *Arcella mitrata* Leidy. The structure of the test in Arcella is usually described as given by Leidy ("Fresh-water Rhizopods of North America," *U. S. Geol. Surv. Territories*, vol. 12, p. 167): "Composed of a more or less translucent or transparent chitinoid membrane, with a minutely hexagonal cancellated

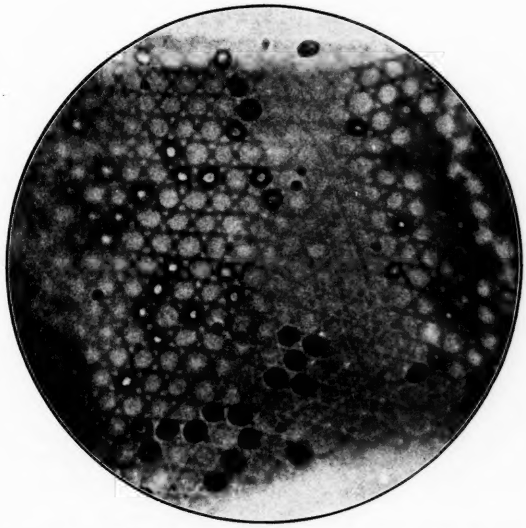

FIG. 1.— *Arcella vulgaris* Ehrenberg. ×3100. Showing many air bubbles in the cancelli and the structure of the network. Photomicrograph, $\frac{1}{12}$ in. oil-immersion objective.

structure." Closer study of the test of these two species with high magnification shows further complication of this structure, not shown at all in the "honeycomb" figure given by Leidy, Pl. 27,

Fig. 35. Moreover, as will be shown later, the arrangement of the hexagons is on an entirely different plan from that shown in Leidy's figure and those of other authors.

Hertwig and Lesser (*Arch. f. mikr. Anat.*, vol. 10, suppl., 1874) after reviewing and rejecting the conclusions of Dujardin, Ehrenberg, Claparède, Carter, and Wallich go rather fully into the more minute structure of the test and reach a positive conclusion as follows (p. 96): "Ihrer feineren Structur nach besteht die Schale aus zwei Platten, einer äusseren und einer inneren, welche einan-

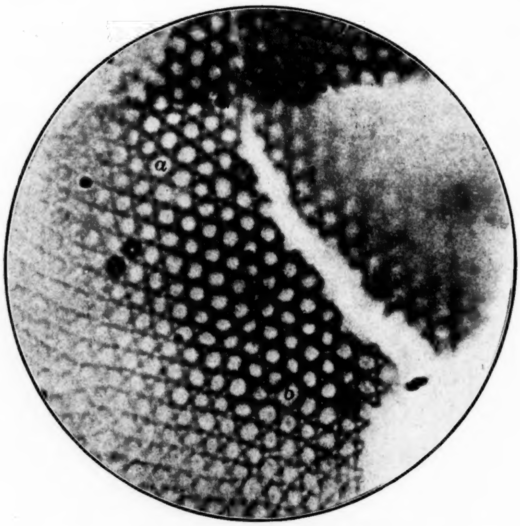

Fig. 2.— *Arcella vulgaris* Ehrenberg. ×3100. Showing the introduction of columns of plates and resulting change in the number of sides of the plates. *a*, heptagonal plate; *b*, *b*, irregularities with more than one column initiated.

der parallel gelagert sind und durch ein bienenwabenartiges, hexagonale Figuren bildendes Fachwerk vereint werden"

Hertwig and Lesser, by treatment of the test with sodium carbonate and acetic acid induced the formation of bubbles of carbonic-acid gas in the cancelli, which they considered closed chambers. In our specimens many bubbles of air were introduced into the cancelli with the greatest ease in the following manner. From about the entire test, under low power, the water was

drawn away until its level was so reduced that air reached the specimen. Bubbles at once formed in some of the cancelli and were present after dehydrating, clearing, tearing in pieces, and mounting in balsam or styrax. Many of these air bubbles are seen in Fig. 1, and a few are scattered about in Fig. 2. The ready entrance of air to form bubbles in the cancelli hardly seems to bear out the view that there are two thin plates, with the cancellated network lying between, as Hertwig and Lesser thought. If there were two membranes, it would be impossible, by the simple method adopted in this work, to cause air bubbles to form in the closed chambers lying between them. That there is but one membrane is very strongly indicated by the present study.

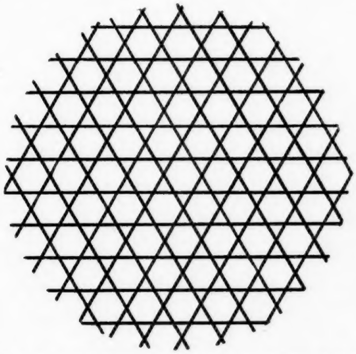

FIG. 3.— Diagrammatic representation of the structure of the upper surface of the network.

The next thing to determine was the position of the single membrane, whether it is on the outer or the inner side of the network. In the introduction of air bubbles the specimens were placed with the mouth-opening downward, the shell cavity being filled with water. At no time was the water allowed to become low enough to permit air to enter the mouth. In this manner only the upper surface was exposed, and no air could have entered the cancelli from the inside. Moreover, had air entered the shell cavity, it would at once have become evident as a large air bubble at the upper part of this cavity. The introduction of air having been thus controled, we conclude that the bubbles formed on the outside of the membrane, and therefore that the raised pattern or network projects externally.

The form of this network, as has been said, is radically unlike the honeycomb structure heretofore assigned to it. It is, to be sure, hexagonal in its main features, but the arrangement of the hexagonal areas is not at all what it has been represented. In the honeycomb arrangement the hexagons have sides in common.

In the Arcella test the hexagons have no sides in common. Instead, the hexagonal areas are so placed that the three adjacent sides of three neighboring areas enclose a small triangular space. Just here we find a further complication of the structure. These interpolated triangles are not solid portions of the network, but themselves contain areoles of subtriangular outline. The density of the medium through which the light is transmitted seemed, with the best illumination obtainable, the same in the small triangular areoles as in the larger hexagonal areas. From this we concluded that the areoles are depressed areas in the network

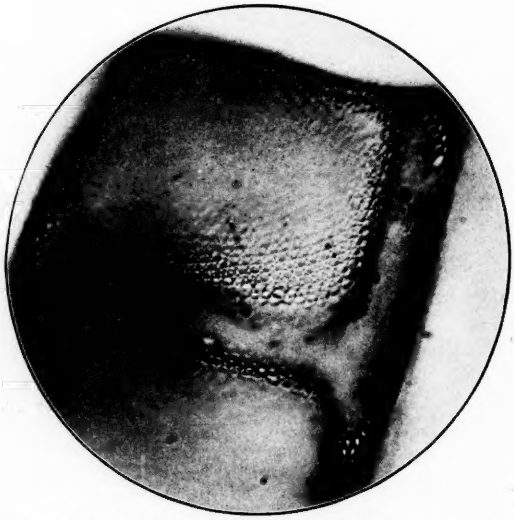

FIG. 4.— *Arcella mitrata* Leidy. ×1200. Photomicrograph showing structure of network like that in *A. vulgaris*.

similar, except in point of size and shape, to the hexagonal areas. Diagrammatically then, the network may be conceived as formed of straight lines in three sets of parallels, the lines of each set making an angle of sixty degrees with those of the two other sets (see diagram, Fig. 3). A comparison with the actual photographs, especially Fig. 2, seems to bear out this conclusion. That no air bubbles formed in the smaller spaces is natural, since the surrounding areas are much larger and of equal depth.

When the test was seen in optical section the reason for the view that there are two membranes was apparent, for the limiting upper edges of the raised network give the appearance of a wall covering in the top. This appearance seems to be merely the effect of refraction of light. The basal membrane may be clearly seen. In general the height of the raised network above the basal membrane is about equal to the width of the hexagonal areas.

Besides the further complication of structure in the test, another

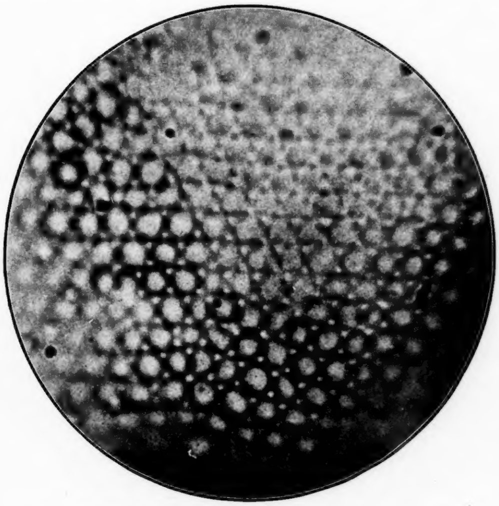

Fig. 5.— *Arcella mitrata* Leidy. ×3300. Photomicrograph of a portion of the specimen shown in Fig. 4, but much enlarged.

series of observations was made on the method of growth of the shell. As the animal increases in size toward the periphery, this increase must in some way be provided for. An increase in size of the hexagons might have been used but this would have been detrimental to the plan of structure. Instead of this, new columns of hexagonal areas are added or interpolated among the previous ones. By this means the plan of structure is not seriously interfered with. These new columns may be added in any of three directions conforming to the directions of the three sets of parallel lines already referred to.

In typical cases the new column of plates is initiated by an area having but five instead of six sides. To compensate for this mechanically, the preceding area has seven sides (Fig. 2, *a*). This equating method of heptagons and pentagons is typical whenever a single column is added in one spot. In certain cases, however, more than one column may originate, even with the same area, and then various irregularities are taken on (Fig. 2, *b*). In such cases, areas with but four sides are met with occasionally instead of the normal pentagonal areas. Besides this variation in the number of sides of the areas in different portions there seems to be a definite alternation of the columns, to the right and left of the axis in which they are added. This applies of course only to those columns added successively in one of the three directions mentioned above.

Altogether, the test of Arcella is far from the simple hexagonal structure figured by Leidy and other authors. Its complexities are worthy of further study and comparison with the tests of other rhizopods.

NOTES AND LITERATURE

ASTRONOMY AND PHYSICS

A Laboratory Astronomy.[1] — This book is the outcome of the author's experience in handling with his large elementary classes in Harvard College, "those difficult and discouraging" parts of astronomy which deal with "the diurnal motion of the heavens and the apparent motions of the sun, moon, and planets among the stars." It is suggested that each student ought to make for himself, and discuss carefully, a great number of simple observations, so that the facts to be brought out may become a part of his own experience. The apparatus required, most of which has been especially designed for this work, is so inexpensive that each student can be supplied with a complete outfit. This makes it possible for all the members of a class to do similar work at a given time — "a principle of cardinal importance in elementary laboratory work with large classes." The book is intended primarily for teachers and should be used in connection with a descriptive text-book.

No one who knows Professor Willson personally, will need the reviewer's assurance of the remarkable ingenuity of his methods, or of the admirable qualities of his style. This book is a fine example of a modern tendency, new in astronomy, but fortunately well established in physics and chemistry, of carrying interesting laboratory work into the very beginning of a student's acquaintance with natural science.

A feature of interest to the general reader is a well written chapter on the contents and use of a nautical almanac, with a full set of specimen pages.

H. N. D.

A Laboratory Physics.[2] — This book, like the one just reviewed, is intended as a laboratory manual for a large elementary course in Harvard College, and presents such material as might form a set of

[1] Willson, Robert W. *A Laboratory Astronomy.* Boston, Ginn and Co., 1906. 8vo, ix + 189 pp.

[2] Sabine, Wallace C. *A Student's Manual of a Laboratory Course in Physical Measurements.* Rev. ed., Boston, Ginn and Co., 1906. 8vo, vi + 97 pp.

"daily lectures preceding the laboratory work and describing the experiments to be performed." It is, nevertheless, remarkable for its freedom from the pedantic, cut-and-dried, schedule method of presentation which so frequently characterizes elementary laboratory manuals, for many of Professor Sabine's pages are interesting reading as such, and throughout, "too specific instruction" has been avoided as tending "not only to deprive the student of initiative but also to make any departure in the apparatus confusing."

As a matter of fact the spirit of the book would have been better expressed by reversing the order of these two clauses, for "in the majority of cases the description is purposely not such as will admit of a mechanical and unintelligent interpretation." In particular, the three-page introduction is an unusually fine presentation of the point of view from which a student should attack the work which is to follow.

The experiments described are representative of nearly the whole range of elementary physics. They should properly be preceded by the still more elementary work of a modern high-school course, as much of the apparatus requires comparatively skilful and appreciative handling. Two short appendices on "significant figures" and "graphical representation" are especially worthy of mention.

H. N. D.

BIOLOGY

Clements's Research Methods in Ecology [1] is the outcome of some eight years of practical work by the author in the experimental study of the factors that determine the distribution and adaptive modifications of plants. Students of this comparatively new branch of science are to be congratulated on the possession in this volume, of a concise statement of the aims, methods, and problems of ecology. The author points out that the greater part of so called ecological study has hitherto been very superficial and of comparatively little value, largely because of a failure to recognize and measure accurately the several factors that determine for each species its particular environment.

[1] Clements, F. E. *Research Methods in Ecology.* Lincoln, Neb., University Publishing Co., 1905. 8vo, xvii + 334 pp., 85 figs.

The subject matter is considered under four main heads. Chapter I is devoted to a general statement of the scope of ecology. Chapter II deals with habitat, and contains a description of the instruments and methods used in recording water-content, light-intensity, temperature, soil, and other factors upon which the organism is dependent. Many of the methods described, have been elaborated by the author in his own extensive work in the West. Chapter III, the Plant, considers the general relations, adaptations, and reactions of the separate organism, while Chapter IV deals with the Formation in its various aspects, and the methods of studying the relations that groups of plants bear to one another and to their environment.

This work should do much towards establishing ecology and experimental plant evolution upon a firmer basis by pointing out the need and the method of making absolute determinations of factors, instead of the inaccurate generalizations so often recorded. The time is also not far distant when it will be a simple matter to determine, by an examination of a given soil in a given situation, what plants are best adapted to any portion of a single farm, so that agriculture may be carried on under much more precise regulations.

Although plants alone are dealt with in the present volume, many of the methods described will have to be used in a more exact study of animal habitats, and here lies a large field as yet hardly more than touched upon. The author recognizes the zonal distribution of continental forms, and proposes a new nomenclature for these as occurring in North America. Apparently, however, the areas already recognized and named by American zoölogists are ignored, and the new classification given, does not seem as adequate as that now in use by the latter.

A glossary, including numerous terms proposed by the author, and a bibliography of plant ecology complete the book. Notwithstanding the very detailed statement of contents, the lack of an index is a disadvantage.

G. M. A.

Moore's Universal Kinship [1] is intended as a protest against that attitude of the human mind that would conceive all animals other than man as man's just and legitimate prey. The author appears to have become greatly impressed by Darwin's conception of the

[1] Moore, J. H. *The Universal Kinship.* Chicago, Chas. H. Kerr and Co., 1906. 12mo, x + 330 pp. $1.00.

ultimate consanguinity of all sentient beings, and addresses himself to the task of arousing in man a greater feeling of sympathy for his fellow creatures. The argument falls under three heads: man's physical relation to other animals, his psychical similarity to them in certain fundamental ways, and hence his ethical kinship. The author concludes that the fact "that vertebrate animals, differing in externals as widely as herring and Englishmen, are all built according to the same fundamental plan, with marrow-filled backbones and exactly two pairs of limbs branching in the same way, is an astonishing coincidence"; hence the fancied superiority of the human race is but a figment of man's mind for "man is not a god, nor in any imminent danger of becoming one."

While agreeing with the author that "the art of being kind" is in sore need of cultivation among us, one cannot but be amused at the mixture of fact and error, observation and travelers' tales, seriousness of statement and straining after absurd expressions, that characterizes this not unreadable book.

G. M. A.

ZOÖLOGY

Pratt's Vertebrate Zoölogy.[1]— In continuation of the plan of his *Invertebrate Zoölogy*, published some three or four years ago, Dr. Pratt now offers a similar guide to the dissection of vertebrates, which would appear to merit the same favorable reception accorded to the earlier volume. As a guide to vertebrate dissection its chief claim to usefulness over the already existing laboratory manuals on the subject lies perhaps in the fact that it includes under one cover those forms most frequently employed in American laboratories, for descriptions of which the teacher or student has formerly found it necessary to refer to two or three separate works. Outlines are furnished for the dissection of seven types, *viz.*: dogfish, perch, mud-puppy (Necturus), frog, turtle, pigeon, and cat. Of these, that of Necturus will probably be especially acceptable, since it is a form commonly

[1] Pratt, Henry Sherring. *A Course in Vertebrate Zoölogy. A Guide to the Dissection and Comparative Study of Vertebrate Animals.* Boston, Ginn and Co., 1905. 8vo, x + 299 pp.

employed for laboratory work in connection with courses on comparative vertebrate anatomy, and heretofore no published outline for its dissection has been generally accessible.

The question as to the practical and pedagogical value of manuals of this nature remains, as before, an individual one with different teachers. In respect to method of treatment the present outlines offer few innovations; but apparently the attempt has been made to have them as practical as possible, so that they may, if it is desired, be placed in the student's hand with little or no modification. To this end the descriptions are made rather fuller than some instructors might consider desirable, especially those who believe that laboratory outlines should consist merely of a framework of directions as to the method of proceeding to work, together with suggestive questions, rather than a description of what the student is expected to see. Dr. Pratt has largely overcome this objection by the relatively great number of original drawings called for. Satisfactory drawings insure that the student has seen what is described, and the omission of all illustrations from the book will make him dependent upon his own observations in supplying these.

L. J. C.

Stephens's California Mammals[1] is a handbook written to popularize the study of the rich mammalian fauna of that State. In addition to a brief description of each species with a statement of its distribution, the author has given a number of field notes on the forms that have come under his personal observation. The accounts of the Cetacea are taken from Scammon as the author has had no experience with them. The nomenclature used for these animals is in some cases not that now in vogue. The scientific names of the species considered, are followed by the name of the authority as usual, but the author tells us that he has omitted the parentheses in all cases where they are usually employed. This seems a mistake in a work of this sort. The chapter on life zones is accompanied by a chart showing the location of these areas. A check-list and glossary are followed by a very complete index. Several rather characterless wash drawings serve as full page illustrations.

The work can be but preliminary, the author states, but undoubtedly it will be of value as a basis for a more thorough investigation.

G. M. A.

[1] Stephens, F. *California Mammals.* San Diego, Cal., West Coast Publishing Co., 1906. 8vo, 351 pp., illus. $3.50.

Ichthyological Notes.—In the *Bulletin of the Bureau of Fisheries* (vol. 25, 1905), Dr. Barton W. Evermann has a beautifully illustrated memoir on the "Golden Trout of the High Sierras." In small streams tributary to Kern River, along the flanks of Mount Whitney are found small trout, very gorgeously colored, with brilliant golden and orange shades on the bodies and fins. These colors harmonize with the orange colors of the underlying rocks. Recently Dr. Evermann, at the request of President Roosevelt, conducted an investigation of these trout. He finds them probably descended from the Kern River Trout (*Salmo gilberti* Jordan), but modified in size, in coloration, and in the reduction of the scales. From the Kern River Trout, the Golden Trout are separated by impassable waterfalls. But still more remarkable is the fact that in each of the three different streams thus isolated, there is a different type or species of Golden Trout. Besides the original species, *Salmo aguabonita* Jordan, from South Fork of Kern River, Evermann describes two new species, closely allied to this, but each sprung independently from the same parent stock. These species are: *Salmo roosevelti* Evermann, from Volcano Creek, and *Salmo whitei* from Soda Creek.

It is not certain whether the vivid colors of each of these three species are protective, due simply to natural selection, or whether to some more obscure influence acting on all individuals in these mountain brooks. The paper is illustrated by paintings by Charles B. Hudson and by maps and photographs of the waterfalls and streams within the habitat of the Golden Trout.

In the same *Bulletin* for 1904, Dr. Charles Wilson Greene of the University of Missouri has published his studies of the physiology of the Chinook Salmon, a species of especial interest from the fact that every individual dies after reproduction.

In the *Smithsonian Miscellaneous Collections*, 1905, vol. 48, Mr. Barton A. Bean gives an account of the Whale Shark (*Rhinodon typicus*), the largest of the sharks, a specimen of which has been lately taken on the coast of Florida. The same shark has been described from the Gulf of California as *Micristodus punctatus*, and lately from Japan as *Rhinodon pentalineatus*.

In the same number, Dr. Theodore Gill gives an essay on the Cyprinoid fishes, with figures of numerous species and a discussion of the vernacular names current in England and America.

In the *Proceedings of the Washington Academy of Science*, Robert E. Snodgrass and Edmund Heller record the fishes taken about the

Galapagos Islands by the Hopkins-Stanford Expedition of 1898; 184 species are recorded, with synonymy and valuable notes on their characters and geographical distribution. The new species has been described in a previous paper.

In the same *Proceedings*, Mr. William F. Allen, also of Stanford University, describes in great detail the lymphatic system in the large Californian Sculpin or Cabezon, *Scorpænichthys marmoratus*.

In the *Proceedings of the Royal Society of Edinburgh*, Dr. Louis Dollo describes the abyssal fish, *Bathydraco scotiæ*.

In the *Proceedings of the Biological Society of Washington* (1905) Dr. Seth E. Meek, records a collection of fishes from the Isthmus of Tehuantepec. *Cichlasoma zonatum*, from Oaxaca, is described as new. Dr. Meek also describes two new species, *Pimelodella eigenmanni* from Sao Paulo, Brazil, and *Anisotremus williamsi* from Santos.

In the *Proceedings of the Philadelphia Academy* for 1905, Mr. Henry W. Fowler discusses a collection of ninety species of fishes from the Baram Basin in Borneo. Most of these are fresh-water species, several new genera and species being described. One goby, *Gigantogobius jordani*, allied to Eleotris, reaches a length of 26 inches.

Numerous papers in the *Annals and Magazine of Natural History* by C. Tate Regan, treat of fishes. The following matters may be noted: Regan records the European shark, *Hexanchus griseus*, from Japan and concludes that the Californian species, *Hexanchus corinus* is not distinct from it. He gives reviews of various groups of South American fishes, especially Cichlidæ and Loricariidæ. A new white-fish, *Coregonus gracilior*, is described from the Lakes of Cumberland. A monographic review of the family Galaxiidæ is given by Mr. Regan in the *Proceedings of the Zoölogical Society of London*.

Dr. George A. Boulenger, as President of the Zoölogical Section of the British Association for the Advancement of Science (1905), discusses in illuminating fashion the distribution of African fresh-water fishes. In the *Annals and Magazine of Natural History*, July, 1905, Dr. Boulenger gives a list of the fresh-water fishes of Africa with the distribution of each species. In the *Proceedings of the Zoölogical Society*, he records the fishes of Lake Chad. All the species are common both to the Nile and the Niger, a fact which indicates that a connection between these rivers formerly existed through Lake Chad.

In the *Scientific Investigations of the Fisheries of Ireland,* for 1905, Messrs. E. W. L. Holt and L. W. Byrne, give a "First Report on the Fishes of the Irish Atlantic Slope." A new species is *Melamphaës eurylepis. Nettophichthys retropinnatus* of Holt is shown to be the young of the eel, *Synophobranchus pinnatus.* The genus Myctophum in this paper is called by the much later name of Scopelus.

Professor Keinosuke Otaki, and his associates, Fujita and Higurashi, continue their beautifully illustrated work on the fishes of Japan. In the third issue are included the Kurodai (*Sparus schlegeli*), the Maguro, or Tunny (*Thunnus schlegeli* = ? *Thunnus thynnus*), the Maiwashi or Japanese Sardine (*Sardinella melanosticta*), the Konoshiro (*Konosirus punctatus*), and the Common Goldfish or Funa. The press work in this series is beautifully done, and the text is accurate and helpful.

In the *Journal of the College of Science* (vol. 20, 1905) of the Imperial University of Tokyo, Shigeho Tanaka has an account of two new species of Japanese Chimæras. It is a remarkable fact that of the ten known living species of this ancient and extraordinary genus, five are known from Japan only, and the center of distribution of each of these is Sagami Bay, which is the first indentation south of the Bay of Tokyo. Mr. Tanaka describes *Chimæra jordani* and *Chimæra owstoni* as new species, in addition to the three, *Chimæra phantasma, Chimæra mitsukurii,* and *Chimæra purpurascens* already described from the waters about Misaki. When we consider the number of rare or ancient sharks recorded from this region, the extraordinary richness of the Bay of Sagami in shark-like types becomes very apparent. It was from Sagami Bay that Garman obtained Chlamydoselachus and Mitsukuri the "Goblin Shark," called Mitsukurina. In the same bay is a Rhinachimæra, a Heterodontus, and many species of Squaloid sharks, one of them with luminous areas on the body.

Other Japanese sharks are described by Garman in the *Bulletin of the Museum of Comparative Zoölogy* (vol. 46, 1906). These are: *Parmaturus pilosus, Centrophorus acus, Centrophorus tessellatus, Acanthidium rostratum, Acanthidium aciculatum,* and *Centroscymnus owstoni.* To Parmaturus, the Japanese species, *Pristiurus eastmani,* is also referred, as also *Catulus xaniurus* from California. Garman refers the genus Deania to the synonymy of Acanthidium and Zameus to that of Centroscymnus. *Squalus uyatus* of Italy is referred to Centrophorus. Garman describes *Hemigaleus pectoralis,* as a new species from the New England Coast.

Japanese fishes are also discussed in several papers in the *Proceedings of the United States National Museum* for 1905. Jordan and Seale describe six new species from different parts of Japan, the most notable being a new genus, Sayonara, near Anthias. The fishes of the islands of Yaku and Tanega, as collected by Robert V. Anderson, are recorded by Jordan and Starks. Seven of these, mostly blennies, are figured as new. Jordan and McGregor describe as new, the Japanese Threadfin or Agonashi, *Polydactylus agonasi*. Jordan reviews the sand-lances of Japan, and Jordan and Snyder review the sturgeons. An elaborate paper on the many species of flounders and soles of Japan is by Jordan and Starks. Jordan and Herre review the Japanese herrings, and Snyder the Japanese surmullets. Jordan and Snyder discuss the Giant Bass of Japan, *Stereolepis ischinagi*, a species closely related to the California Jewfish, and *Erilepis zonifer*, the huge Aburabodzu or Fat-priest of Japan. This species was first known from a single specimen taken by Lockington in the Bay of Monterey.

Jordan and Snyder discuss the killifishes of Japan, and also the Chinese loaches of the genus Misgurnus. The fishes of Shanghai are discussed by Jordan and Seale, and those of Port Arthur by Jordan and Starks. Among the latter is a remarkable new genus of gobies, Ranulina, with the teeth fringe-like about the rim of the mouth.

Mr. Edwin C. Starks reports on the collection of fishes made in Ecuador and Peru, by the late Mr. Perry O. Simons, a most promising Stanford student, conducting explorations for the British Museum, who was murdered by highwaymen in Bolivia in 1899. In the same *Proceedings*, Dr. Evermann and H. W. Clark describe three new species from Santo Domingo, *Platypœcilus perugiæ*, *Platypœcilus dominicensis*, and *Sicydium buscki*. Eugene W. Gudger discusses the breeding habits and embryology of a species of pipe-fish, *Syngnathus floridæ*.

In the *Proceedings of the Davenport Academy of Sciences* (vol. 10, 1905), the memorial volume dedicated to Mrs. Putman, the honored patron of the Academy, Jordan and Seale discuss the fishes of Hong Kong. This paper is beautifully illustrated, two of the plates being colored.

In the *National Geographic Magazine*, 1905, Dr. Hugh H. Smith treats in detail of the Japanese fisheries.

In the *Zoölogisches Jahrbuch* for 1905, is a paper by the late Professor Franz Hilgendorf of Berlin on fishes from East Africa.

Dr. Robert Collett, in the *Forhandlinger Videnskabs Selskab* of Christiania for 1905, continues his monographic reviews of the fishes of Norway.

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In the *American Naturalist* (vol. 39, 1905), Miss Julia Worthington discusses the Myxinoids or hag-fishes, as studied by her at the Stanford Seaside Laboratory at Pacific Grove. Miss Worthington rejects the genus Polistotrema, detached from Eptatretus (which she calls by the much later though more familiar name of Bdellostoma), regarding the number of gills as having barely specific importance. The separation into genera may be questionable, but there is as yet no adequate reason for placing all these variant forms in a single species, an arrangement first suggested by Dr. Howard Ayers.

In the *Bulletin of the American Museum of Natural History*, Mr. L. Hussakof gives a valuable account of the structure of two species of Dinichthys. In the *American Journal of Science*, Dr. C. R. Eastman makes a strong argument in favor of the dipnoan affinities of the Arthrodires. He goes far towards placing Woodward's view of the case on a sound foundation. The contention of Eastman rests largely on the intimate relationship of the dipnoan Neoceratodus to the Arthrodires on the one hand and to characteristic dipnoans on the other, the living genus Neoceratodus being more primitive than either of the extinct types with which it is compared. Dr.

Eastman does not believe that dipnoans are descended from Crossopterygians, but rather that they may have come from the Pleuracanthus-like sharks. The association of the Arthrodires with the Dipneusti, finally disposes of the group of Placodermata, in which the Arthrodires were associated with the Ostracophores.

In the *Bulletin of the University of Montana,* Dr. James A. Henshall gives a list of the scant fish fauna of Montana, 36 species being represented, with notes on the game fishes represented or introduced into the State.

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In the *Marine Biological Association Report* (vol. 1, 1903), are elaborate studies of the Plaice, *Pleuronectes platessa.* Dr. William Wallace has investigated the growth rate of the species. Walter Garstang reports on the topographical distribution of the species. A number of studies on the natural history of the Plaice are recorded in German by Mr. Garstang in *Rapports du Conseil International pour l'Exploration de la Mer,* 1905.

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discovery of a vestigial sixth branchial arch in the shark, Heterodontus. As in the more primitive groups of Hexanchidæ and Chlamydoselachidæ, there are six or seven gill arches, this discovery of six arches in the still more ancient group of Heterodontidæ, the oldest of existing sharks, is a matter of much interest and importance. The number five found in all other recent sharks is apparently a matter of specialized reduction.

In the *Annals of the New York Academy of Sciences*, 1906, Dr. Raymond C. Osburn makes a strong and convincing argument for the theory of the origin of the vertebrate limbs from fin folds. Dr. Osburn contends that paired and unpaired fins in fishes are similar structures and that the evidence is overwhelmingly in favor of the origin of all fins as local outgrowths from the body wall.

David Starr Jordan

BOTANY

Leaf Structure.—A paper by Mrs. Clements,[1] which contains a historical review of the work previously done along similar lines, is based upon observations made on some 300 species growing under the varied conditions presented by the Colorado foothills and the mountains of the Pike's Peak region of the Rocky Mountains. The conclusions arrived at support the views now generally held as to the influence of local conditions upon the histological structure of leaves, and are based upon exceedingly extensive and precise measurements relating to water-content of soil, humidity, light, and temperature, all of which factors are brought into relation with the histological structure of stem leaves. Thanks to the system of classification adopted as well as to the numerous comparative tables, the reader, at a glance, is able to note with exactitude the influence of each of the factors upon leaf structure, in which he is aided by a large number of excellent illustrations.

The statement: "Full sunlight is equally strong throughout the regions, and not more intense for high altitudes, as is generally supposed" [p. 28] is to be noted, in view of Professor Wiesner's recent conclusions to the contrary.

H. Hus

[1] Clements, E. S. "The Relation of Leaf Structure to Physical Factors." *Trans. Amer. Micr. Soc.*, 1905, pp. 19–102, 9 pls.

Light Intensity.— Professor Wiesner [1] now gives a detailed account of his measurements of light intensities, made chiefly in the Yellowstone Park, and reaches the conclusion that, with a clear sky, the intensity of the total daylight as well as that of the direct sunlight increases with the elevation above sea level, while the intensity of the diffused light decreases with increasing elevation but constant altitude of the sun. He further finds that the diffused light, in the course of the day, does not increase correspondingly to the increase of direct sunlight.

The greater intensity of the total daylight on the surface of the sea as compared to that on the main land, Professor Wiesner ascribes to the greater amount of light reflected by water surfaces.

H. Hus

Bilancioni's Dictionary.[2]— A capital model of a modern botanical dictionary is afforded by a little book recently published in the Italian language. Histology, anatomy, morphology, physiology, and the biology of plants are indicated among the topics treated, and 111 pages are given to a biographic account of distinguished botanists. The treatment of the several entries ranges from a mere indication of equivalence in the case of synonymous words to four pages (including a classification) for fruit, two and a half for germ-plasma, three and a half for protoplasm, eleven for tissues, etc. Plant names do not appear; but common Latin adjectival forms on which specific names have frequently been framed, are defined, and throughout the derivation of terms is given.

W. T.

Notes.— A little pamphlet of 109 pages, by Professor Bessey, has been issued by the University Publishing Company, of Lincoln, Nebraska, under the title *Elementary Botany*. Laboratory and field instructions are followed by a terse manual of the common genera of Nebraska plants.

One of the most attractive of recent elementary text-books is Miss

[1] Wiesner, J. "Beiträge zur Kenntnis des photochemischen Klimas des Yellowstone-Gebietes und einiger anderer Gegenden Nord Amerikas." *Denkschr. d. math. naturw. Kl., kaiserl. Akad. d. Wissensch., Wien,* vol. 80, 1906.

[2] Bilancioni, G. *Dizionario di botanica generale.* Milano, Hoepli, 1906. 16mo, xxi + 926 pp. 10 lire.

Stoneman's *Plants and their Ways in South Africa.* Familiar facts are supplemented by (to us) unfamiliar illustrations.

Some new plants from the Canadian Rockies and Selkirks are described by Miss Farr in *The Ottawa Naturalist* for August.

Vol. 7 of Engler and Drude's *Vegetation der Erde* is devoted to a part of West Australia, treated by Diels.

Chevalier gives an illustrated account of Adansonia in no. 6 of the current volume of the *Bulletin de la Société Botanique de France.*

Mr. A. D. E. Elmer has begun the publication, at Manila, of a new serial under the title *Leaflets on Philippine Botany.* The first number, dated April 8, is devoted to a paper on Philippine Rubiaceæ, by the editor.

Goodale has a note on the persistence of Calluna in Massachusetts in *The American Journal of Science* for August.

Viguier publishes the results of an anatomico-systematic study of Araliaceæ in ser. 9, vol. 4, nos. 1–3, of the *Annales des Sciences Naturelles, Botanique,* issued in July.

The flowering of *Agave palmeri* and *A. lecheguilla* is reported in the *Journal of the New York Botanical Garden* for August.

Aloe campylosiphon is figured by Berger in *Die Gartenwelt* of August 11.

Showers of conifer pollen in Mexico, and its accumulation on the water in the crater of Toluca, are recorded by Urbina in vol. 3, no. 7, of the *Anales del Museo Nacional de Mexico.*

An account of the poisoning of horses by *Equisetum arvense* is given by Peters and Sturdevant in the *19th Annual Report of the Agricultural Experiment Station of Nebraska,* which also contains a paper on a disease of the Cottonwood due to *Elfvingia megaloma,* by Heald, and a study of the relation of early maturity to hardiness in trees, by Emerson.

The second supplement to vol. 1 of *The Philippine Journal of Science,* issued on June 15, is devoted to descriptions and figures of new Philippine ferns, by Copeland.

A fully illustrated article on fern buds is published by Kupper in *Flora* of July 25.

Evans contributes some notes on Japanese Hepaticæ to the *Proceedings of the Washington Academy of Sciences* for August.

A monograph of Swiss Myxomycetes, by Schinz, has been separately issued from Heft 6 of the *Mitteilungen der naturwissenschaftlichen Gesellschaft* in Winterthur, for 1906.

Portraits of Bateson and several other well known plant breeders or botanists are published in *The Gardeners' Chronicle* of August 4.

MacDougal discusses discontinuous variation in pedigree culture in *The Popular Science Monthly* for September.

Earle publishes a considerable paper on Cuban fungi, with numerous half-tone illustrations, in the *Primer Informe Anual de la Estación Central Agronómica de Cuba*, bearing date of June 1.

A scholarly study of *Jugendformen und Blütenreife im Pflanzenreich*, by Diels, has been issued from the Borntræger press of Berlin, as an attractively printed, well illustrated pamphlet of 130 pages.

The double number of the *Botanische Zeitung* issued on July 15 is devoted to a paper by Vöchting on regeneration and polarity in the higher plants.

A study of the fall of the terminal buds, characteristic of certain trees, is separately issued by Tison from the *Bulletin de la Société Linnéenne de Normandie* for this year.

Details of experimental studies of the effect of frost on trees are given by Soranes in vol. 35, no. 4, of the *Landwirtschaftliche Jahrbücher*, issued in July.

A series of six well illustrated articles on the differentials of trees in winter was published by Professor Weed in the issues of *Forest and Stream* between January 6 and March 31, of this year.

A short appreciative note on Burbank is printed by de Vries in *The Independent* of May 17.

An illustrated account of the botanical garden of Cambridge, England, is given by Zahu in *Die Gartenwelt* for August 18.

An instructive discussion of variations in animals and plants is contributed by Jordan to *The Popular Science Monthly* for June.

An account of de Vries and his critics is given by Gager in *Science* of July 20.

A somewhat radical analysis of plant study and nomenclature is published by C. F. Baker in *Science* of May 25.

A plea for the proper use of "mega" and "macro" in terminology and nomenclature is published by Chamberlain in *Science* of May 25.

Papers on the flora of the Amazon region are being published by Huber in current issues of the *Boletim do Museu Goeldi* of Pará.

A list of the Bryophytes and higher plants — so far as determined — of the Lamao Forest Reserve is published by Merrill as vol. 1, supplement 1, of *The Philippine Journal of Science*; and a discussion of the vegetation of the Reserve, by Whitford, is contained in nos. 4 and 6 of the same volume.

A third part of de Wildeman's "Enumeration des plantes récoltées par Emile Laurent. . . .pendant sa dernière mission au Congo," issued in June from the Vanbuggenboudt press of Brussels, reaches p. 354 and pl. 106.

Vol. 4, part 4, and vol. 5, part 3, of Wood's *Natal Plants* have recently been issued, bringing the former volume to completion.

Further studies of the botany of Kerguelen, St. Paul, and New Amsterdam are being published by Schenck in the *Wissenschaftliche Ergebnisse der deutschen Tiefsee Expedition* of the *Valdivia*.

The seed and seedling of *Trollius albiflora* are described by Ramaley in *University of Colorado Studies* for March.

Further additions and changes are made in Eschscholtzia by Fedde in late numbers of *Repertorium Novarum Specierum*.

Professor Greene, in his *Leaflets* of June 5, expresses a belief in the existence of some hundreds of species of acaulescent violets in the United States, and a disbelief in the existence of any hybrids in the group.

An economic account of *Erodium cicutarium* in Arizona, by Thornber, forms *Bulletin no. 52* of the Agricultural Experiment Station of that Territory.

The genus Neobrittonia is proposed by Hochreutiner, in vol. 9 of the *Annuaire du Conservatoire et du Jardin Botaniques de Genève*, for the reception of *Sida acerifolia* Lag.

A large increase in the species of Ptelea is noted by Greene in vol.

10, part 2, of *Contributions from the U. S. National Herbarium*, issued in July.

Hybridization in Eucalyptus is analyzed by Maiden in vol. 10 of the *Report of the Australasian Association for the Advancement of Science*, recently distributed.

Piqueria, Ophryosporus, Helogyne, and other Eupatoriaceous Compositæ are the subject of new series 32 of "Contributions from the Gray Herbarium of Harvard University," by Robinson, which appears as vol. 42, no. 1, of *Proceedings of the American Academy of Arts and Sciences*.

An illustrated monograph of Epilobium, by Léveillé, is being published in the *Bulletin de l'Académie Internationale de Géographie Botanique*.

A revision of 17 genera of North American Vernonioid Compositæ, by Gleason, has been separately issued from vol. 4, no. 13, of the *Bulletin of the New York Botanical Garden*.

A third paper on Canadian Antennarias is published by Greene in *The Ottawa Naturalist* for July.

Rhododendron vaseyi is figured in *Curtis's Botanical Magazine* for June.

An economic account of the mango and its diseases in Hawaii, by Higgins, forms *Bulletin no. 12* of the Hawaiian Agricultural Experiment Station.

A good account of the pecan and its varieties is given by Hume in *Bulletin no. 85* of the Florida Agricultural Experiment Station.

A mammoth plant of *Anthurium veitchi* is figured in *Möller's Deutsche Gärtner-Zeitung* of June 2.

A comprehensive thesis on the "Scobiform" seeds of orchids and other plants, by Hirt, forms no. 30 of the *Mitteilungen aus dem botanischen Museum der Universität, Zürich*.

An illustrated account of the cultivation and preparation of fiber from Phormium is given by Fulton in the *Annual Report* for 1905 of the New Zealand Department of Agriculture.

An important account of certain Indian bamboos is being published by Brandis in current issues of *The Indian Forester*.

Endlich gives an economic account of "Zacaton," — species of Epicampes, — in *Der Tropenpflanzer* for June.

The synonymy of *Eriophorum chamissonis* is discussed by Holm and Fernald in *The Ottawa Naturalist* for June.

Illustrations of the curious Karasaki specimen of *Pinus thunbergii* are given by Miyoshi on plates 29 and 30 of his *Atlas of Japanese Vegetation.*

A short illustrated account of *Sequoia sempervirens* is given by Elliott in *Forest Leaves* for June.

Morphological notes on Cycads are published by Seward in vol. 13, part 5, of the *Proceedings of the Cambridge Philosophical Society.*

Part 3 of Grout's *Mosses with Hand-Lens and Microscope* bears date June, 1906.

An account of the morphology of the fern stem, illustrated by *Dennstædtia punctilobula,* is published by Conard in no. 187 of the *Johns Hopkins University Circular.*

A monograph of Scapania, forming a quarto volume of 312 pages, with 52 plates, has been published by Müller as vol. 83 of the *Nova Acta der k. Leop.-Carol. deutschen Akademie der Naturforscher.*

A revision of the Chareæ of North America, by C. B. Robinson, is separately printed from vol. 4, no. 13, of the *Bulletin of the New York Botanical Garden.*

Part 2 of Holway's *North American Uredineæ* deals with species of Puccinia found on Moraceæ, Santalaceæ, Aristolochiaceæ, Polygonaceæ, Amarantaceæ, Portulacaceæ, Caryophyllaceæ, Cruciferæ, Saxifragaceæ, Crassulaceæ, and Rosaceæ. A notable feature of the work is the frequent illustration, by photo-micrographs from type material, of species reduced to the status of synonyms.

The effect of symbiotic fungi in the germination of Odontoglossum is illustrated by Bernard in *The Orchid Review* of July.

A contribution to a revision of the North American Hydnaceæ, by Banker, forms vol. 12, no. 2, of the *Memoirs of the Torrey Botanical Club.*

A preliminary list of some 500 higher fungi collected about St. Louis has been published by Glatfelter in vol. 16, no. 4, of the *Transactions of the Academy of Science of St. Louis.*

Further infection experiments with *Erysiphe graminis*, confirming the current conclusions as to its physiological differentiation on different hosts, are recorded by Reed in a paper separately printed from vol. 15, part 1, of the *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters.*

Salmon figures the Venturias and associated Fusicladiums of apple and pear in *The Gardeners' Chronicle* of July 14.

Glœosporium psidii is shown by Sheldon, in *Bulletin 104* of the West Virginia University Agricultural Experiment Station, to develop an ascigerous stage pertaining to the genus Glomerella,— on the paraphyses of which he has a note in *Science* of June 1.

An illustrated paper on the fungi of scale insects is published by Parkin in vol. 3, part 1, of the *Annals of the Royal Botanic Gardens,* Peradeniya.

An account of fungi and plant diseases, by Clinton, forms part 5 of the *Report of the Connecticut Agricultural Experiment Station for 1905.*

A large number of foliar acarodomatia are described by de Wildeman in vol. 30, no. 2, of the *Annales de la Société Scientifique de Bruxelles.*

An extensive study of palm germination is published by Gatin in the *Annales des Sciences Naturelles, Botanique* of June.

A further account of acarodomatia is given by Borzi in vol. 4, no. 1, of *Contribuzioni alle Biologia Vegetale,* published from the Botanical Institute of Palermo.

Three ferns and 199 flowering plants which grow on trees (without being epiphytes) in parts of Italy are enumerated by Ugolini in the *Commentari dell' Ateneo di Brescia* for 1905.

The sand dunes of Guardamar, and the planting effected on them, form the subject of an illustrated paper by Mira in vol. 4, no. 1–2, of the *Memorias de la R. Sociedad Española de Historia Natural.*

Bruck gives an account of wind injury to foliage in Heft 1 of vol. 20, part 2, of the *Beihefte zum botanischen Centralblatt.*

The biology of a large number of Dicotyledons, from germination to flowering, is traced and illustrated by Sylvén in the recently issued vol. 40, no. 2, of the *K. Svenska Vetenskapsakademiens Handlingar.*

Apogamy is recorded for *Dasylirion acrotrichum* by Went and Blaauw in a separate from the Proceedings of February 24 of the *K. Akademie van Wetenschappen te Amsterdam.*

The conditions which effect the time of the annual flowering of fruit trees are analyzed by Sandsten in *Bulletin no. 137* of the University of Wisconsin Agricultural Experiment Station.

Britton and Viereck publish an extensive record of the insect visitors of orchard flowers in part 4 of the *Report of the Connecticut Agricultural Experiment Station for 1905.*

Mattei gives an account of pollination in Cupuliferæ (of which Castanea, Castanopsis, and Pasania are entomophilous) in vol. 4, no. 1, of the *Contribuzioni alla Biologia Vegetale* of the Botanical Institute of Palermo.

Graenicher contributes pollination notes to the April *Bulletin of the Wisconsin Natural History Society.*

Photograms of common weed seeds found with grass and clover seed are given by Garman in *Bulletin no. 124* of the Kentucky Agricultural Experiment Station.

An illustrated paper on common weeds and their eradication, by Wilson, forms *Bulletin no. 95* of the University of Minnesota Agricultural Experiment Station.

Notes on charcoal and on rubber and gutta-percha, with especial reference to the Philippines, form respectively *Bulletins no. 2 and 3* of the Bureau of Forestry of those islands.

Altamirano contributes an extensive illustrated paper on "guayule" to the May *Boletín de la Secretaria de Fomento* of Mexico.

A number of papers on the constituents of medicinal plants are published in the recently issued vol. 53 of the *Proceedings of the American Pharmaceutical Association.*

A number of northwestern plants are figured, in an economic connection, by Nelson in *Bulletin no. 73* of the Washington Agricultural Experiment Station.

An attractive little tree book, with half-tone illustrations, by Correvon, has been issued by the Atar Company, of Geneva.

Harshberger publishes on phytogeographic influences in the arts and industries of American aborigines in the April *Bulletin of the Geographical Society of Philadelphia.*

A special subscription edition of Bailey and Miller's *Cyclopedia of American Horticulture* has been issued by Doubleday, Page and Co., of New York, in six volumes bound to match their "Nature Library." To what was said of the first edition, from 1900 to 1902, in the *Naturalist* need only be added that the present (fourth) edition contains corrections of detected errors and a conspectus of families and genera prepared by Mr. Miller, while the number of illustrations has been greatly increased.

Under the title *Hortus Veitchii*, Mr. J. H. Veitch has privately printed a sumptuous quarto history of the great plant house of which he is now the head, which is of interest especially for the biographic sketches of its many explorers and hybridists and the remarkable list of plants originated or introduced to European gardens by them. Numerous excellent illustrations add to its attractiveness.

A portrait of Hollós forms the frontispiece to the *Journal of Mycology* for May.

A biographic sketch, with portrait, of C. C. Parry, is contributed to the July number of the *Annals of Iowa* by C. A. White.

A new relief portrait of Rumphius is figured in *Bulletin no. 34 van het Koloniaal Museum te Haarlem.*

The Journals.— *Botanical Gazette*, May: — Elmer, "New and Noteworthy Western Plants — III"; Bergen, "Some Littoral Spermatophytes of the Naples Region"; House, "New and Noteworthy North American Species of Trifolium"; Lewis, "The Basidium of *Amanita bisporigera.*"

Botanical Gazette, June: — Wiegand, "Some Studies Regarding the Biology of Buds and Twigs in Winter"; Yamanouchi, "The Life History of *Polysiphonia violacea*"; Weiss, "The Structure and Development of the Bark in the Sassafras"; Hill, "The Distribution and Habits of some Common Oaks."

Botanical Gazette, July: — Jeffrey and Chrysler, "On Cretaceous Pitoxyla"; Shantz, "A Study of the Vegetation of the Mesa Region East of Pike's Peak: The Bouteloua Formation"; Nelson, "Contributions from the Rocky Mountain Herbarium — VII"; Peirce, "Anthoceros and its Nostoc Colonies"; Hill, "Distribution and Habits of some Common Oaks."

The Bryologist, July: — Fink, "Further Notes on Cladonias — VII"; Collins, "Mounting Mosses, Some Hints"; Hayne, "A List of Hepatics Collected in the Vicinity of Little Moose Lake.... Herkimer Co., N. Y."; Smith, "A List of Mosses Collected on the Adirondack League Club Tract, Herkimer Co., N. Y."; Merrill, "Lichen Notes no. 3, Chemical Tests in Determining Lichens"; Gilbert, "Two Anomalies and a Curious Sight."

Bulletin of the Torrey Botanical Club, May: — Cardiff, "A Study of Synapsis and Reduction"; Cockerell, "Fossil Plants from Florissant, Colorado"; House, "Studies in the North American Convolvulaceæ — I."

Bulletin of the Torrey Botanical Club, June: — Kirkwood, "The Pollen-Tube in Some of the Curcubitaceæ"; Cushman, "New England Desmids of the Sub-Family Saccodermæ."

Bulletin of the Torrey Botanical Club, July: — Spalding, "Absorption of Atmospheric Moisture by Desert Shrubs"; Reed and Smoot, "The Mechanism of Seed Dispersal in *Polygonum virginianum*"; Gleason, "The Pedunculate Species of Trillium."

Fern Bulletin, July: — Klugh, "The Fern Flora of Ontario"; McNeill, "*Botrychium biternatum*"; Palmer, "Green and Red Stiped Lady Ferns"; Clute, "The Moonwort"; Lee, "The Hart's Tongue in Tenn."; Davenport, "The Forms of *Botrychium simplex*"; "A Check-list of the North American Fernworts (*continued*)"; Druery, "*Lomaria spicant bipinnatum* in America."

Iowa Naturalist, January: — Cratty, "Notes on the Iowa Sedges — I"; Anderson, "Additions to the Flora of Decatur County, Ia."; "The Flora of Lake Wabonsie"; Fitzpatrick, "The Iowa Gentians."

Journal of Mycology, March: — Kellerman, "Job Bicknell Ellis" (*with portrait*); Bates, "Rust Notes for 1905"; Saccardo, "Micromycetes Americani Novi"; Bubak, "Einige neue Pilze aus Nord America"; Bessey, "*Dilophospora alopecuri*"; Sumstine, "*Pleurotus hollandianus* sp. nov.," "Notes on *Wynnea americana*"; Ricker, "Second Supplement to New Genera of Fungi Published since the Year 1900, with Citations and Original Descriptions"; Kellerman, "Index to North American Mycology," and "Notes from Mycological Literature — XVIII."

Journal of Mycology, May: — Shear, "*Peridermium cerebrum* and *Cronartium quercuum*"; Morgan, "North American Species of Heli-

omyces"; Ricker, "Second Supplement to New Genera of Fungi Published since 1900, with Citation and Original Description"; Kellerman, "Index to North American Mycology," and "Notes from Mycological Literature — XIX."

Annals of the Carnegie Museum, July: — Jennings, "Additions and Corrections to the List of the Vascular Flora of Allegheny County, Pa."; "A New Species of Kneiffia"; "A Note on the Occurrence of *Triglochin palustris* in Pa."; and "A New Species of Ibidium (Gyrostachys)."

Journal of the New York Botanical Garden, May: — Britton, "Recent Botanical Explorations in Porto Rico."

Journal of the New York Botanical Garden, June: — Murrill, "A Serious Chestnut Disease"; Britton, "A Large Oak Struck by Lightning."

Journal of the New York Botanical Garden, July: — Nash, "The Flowering of Queen Victoria's Agave."

Journal of the New York Botanical Garden, August: — Maxon, "Report on a Collecting Trip in Costa Rica"; Shreve, "A Winter at the Tropical Station of the Garden."

Muhlenbergia, vol. 1, no. 9, July 30: — Osterhout, "Colorado Notes"; Heller, "Western Species, New and Old — VI."

The *Yearbook* of the U. S. Department of Agriculture for 1905, recently issued, contains the following articles of botanical interest: — Webber, "New Fruit Productions of the Department of Agriculture"; Langworthy, "Fruit and its Uses as Food"; Shamel, "The Effect of Inbreeding in Plants"; Rolfs, "New Opportunities in Subtropical Fruit Growing"; True, "Progress in Drug-Plant Cultivation."

The Ohio Naturalist, May: — Claassen, "Key to the Species of Liverworts Recognized in the Sixth Edition of Gray's Manual of Botany"; Kellerman and York, "Additions to the Flora of Cedar Point — I."

The Ohio Naturalist, June: — Schaffner, "Terminology of Organs in Various Conditions of Development"; Jennings, "Additions to the Flora of Cedar Point — II"; Young, "Key to the Ohio Viburnums in the Winter Condition"; Griggs, "A Diurnal Rotation in Leaves of Marsilea."

The Plant World, May: — Andrews, "Some Monstrosities in Trillium"; Harper, "A December Ramble in Tuscaloosa Co., Ala."; Wiegand, "The Passage of Water from the Plant Cell during Freezing."

The Plant World, June: — Cook, "The Disintegrating Influences of Tropical Plants"; Osterhout, "On the Mountain Top"; Bowman, "The Chinese Sumach, or Tree of Heaven,— *Ailanthus glandulosa*"; Harris, "Apparently Imparipinnate Leaves in Cassia."

Rhodora, May: — Lamson-Scribner, "Notes on Trisetum and Graphephorum"; Fernald, "Some Anomalous Plants of Tiarella and Mitella"; Knight, "Some Notes on our Yellow Cypripediums"; Blanchard, "Two New Species of Rubus from Vermont and N. H."; Knight, "Some New Records of Maine Plants"; Holm, "Remarks upon Mr. House's Paper on *Pogonia verticillata*."

Rhodora, June: — Fernald, "*Paronychia argyrocoma* and its New England Representative"; Collins, "New Species, etc., Issued in the Phycotheca Boreali-Americana"; Sanford, "A Station for *Asplenium ebenoides* in Mass."; Davenport, "The Apetalous Form of *Arenaria grœnlandica* on Mt. Mansfield"; Fernald, "A New Variety of *Carex interior*"; Knight, "*Viola novæ-angliæ* in the Penobscot Valley."

Rhodora, July: — House, "The Violet Hybrids of the District of Columbia and Vicinity"; Collins, "Notes on Algæ — VII"; Fernald, "Some New or Little known Cyperaceæ of Eastern North America"; Collins, "Preliminary Lists of New England Plants — XIX" [Buxbaumiaceæ, Georgiaceæ, and Polytrichaceæ].

Torreya, May: — Shreve, "A Collecting Trip at Cinchona"; Barnhart, "Chloronyms"; Berry, "Pleistocene Plants from Virginia."

Torreya, June: — Rusby, "A Historical Sketch of the Development of Botany in New York City"; Harper, "Some More Coastal Plain Plants in the Palæozoic Region of Alabama"; Blanchard, "Two New and Somewhat Anomalous Blackberries"; Eastwood, "The Earthquake and the California Academy of Sciences"; Mackenzie, "*Ranunculus sicæformis*"; House, "A Note upon *Ipomœa cuneifolia*."

Torreya, July: — Rusby, "A Historical Sketch of the Development of Botany in New York City" (*continued*); Greene, "Doctor Torrey

and Downingia"; Blanchard, "Two New Dewberries of the *hispidus* Group"; Britton, "*Galactia odonia*"; House, "A New Southern Convolvulus."

Torreya, August: — Douglas, "The Rate of Growth of *Panæolus retirugis*; Rydberg, "Bassekia or Rubacer"; Rose, "*Terebinthus macdougali,* a New Shrub from Lower California"; House, "Notes on Southern Violets — I."

University of Colorado Studies, June: — Cockerell, "The Fossil Fauna and Flora of the Florissant (Colorado) Shales"; Ramaley, "Plants of the Florissant Region in Colorado."

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